Satellite Analysis

2b. Determine cloud features on satellite imagery.

Concepts

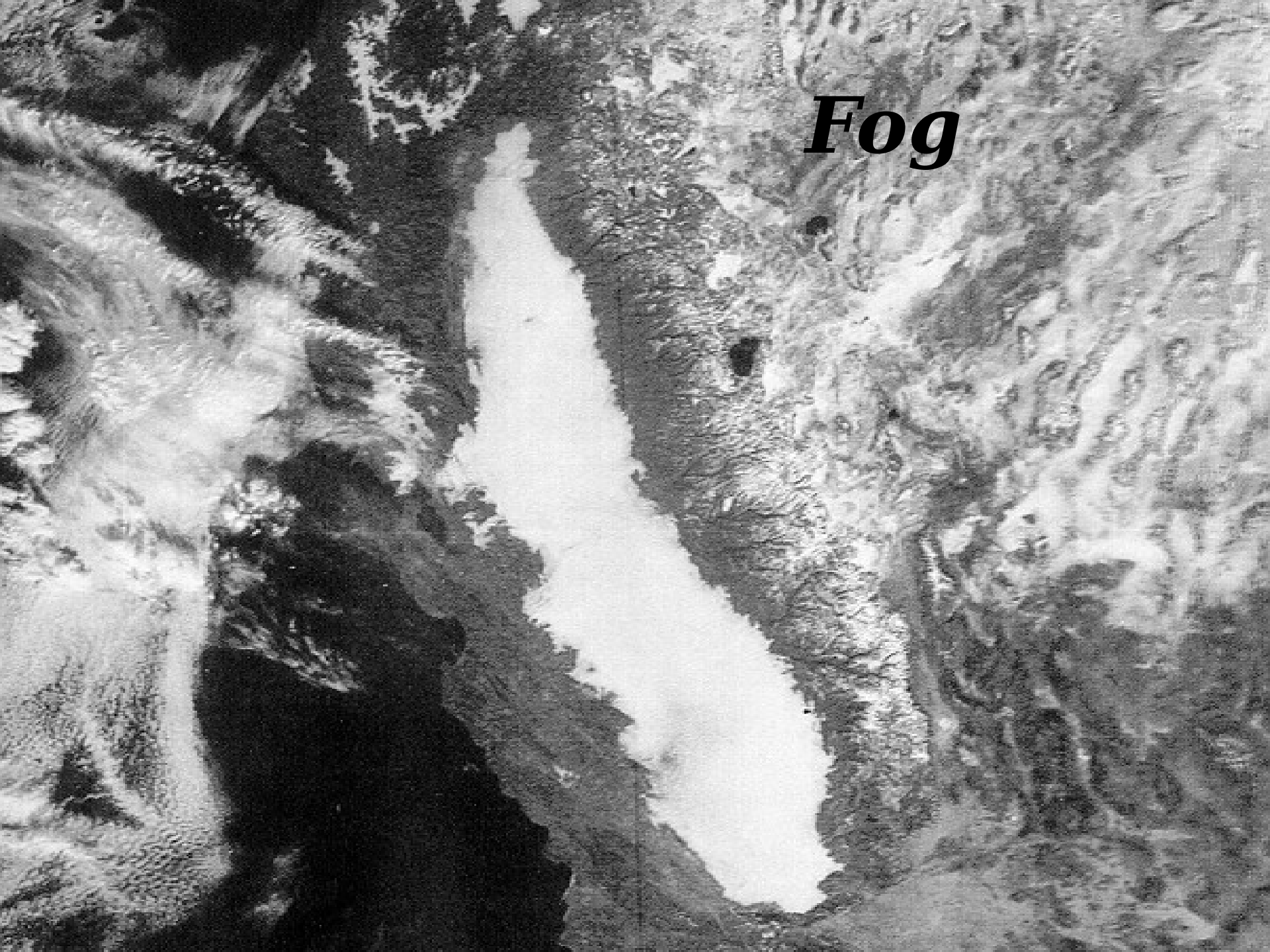
- Synoptic situation
- Use all imagery available
- Continuity
- Terrain

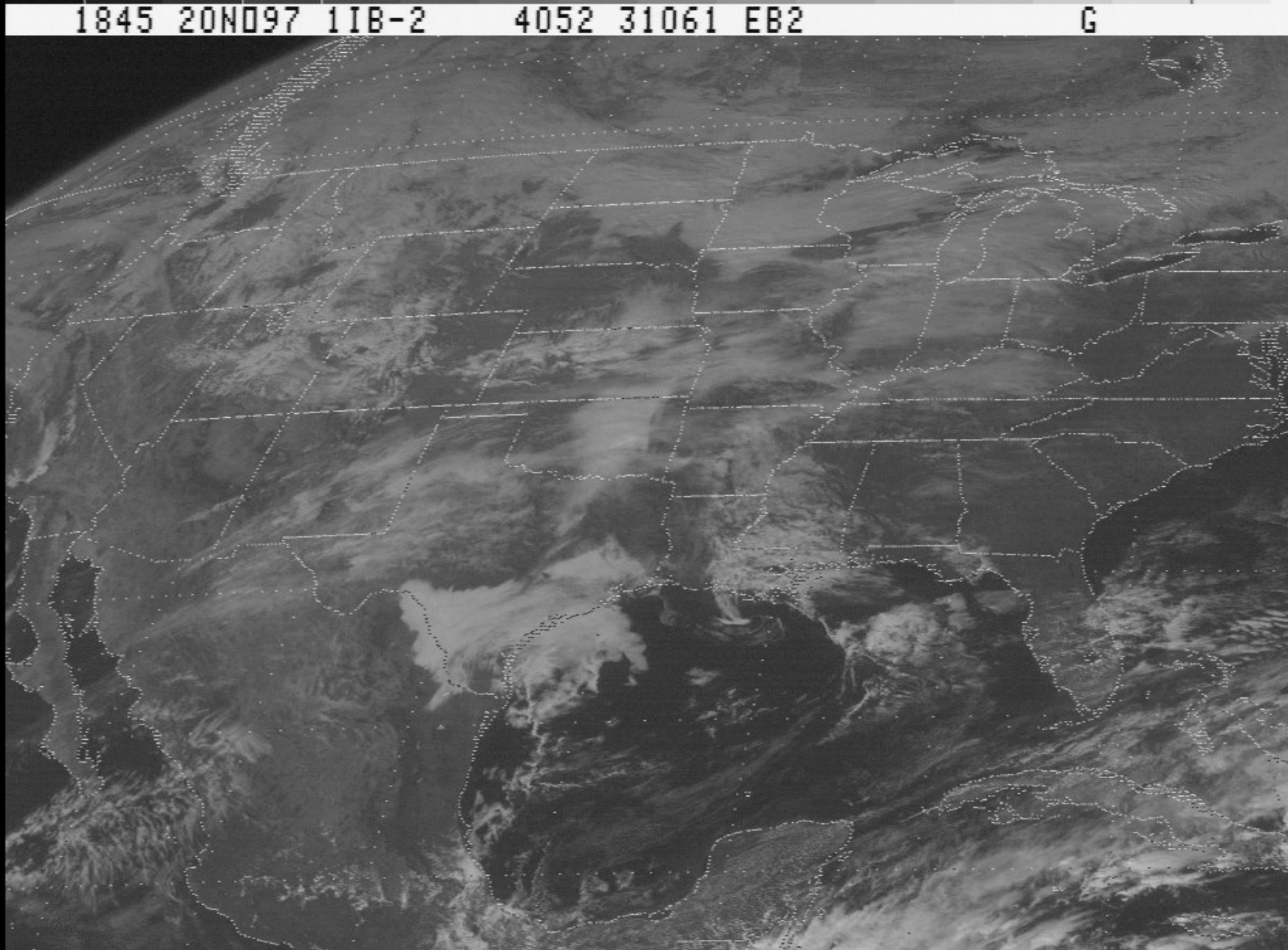
Cloud Identification

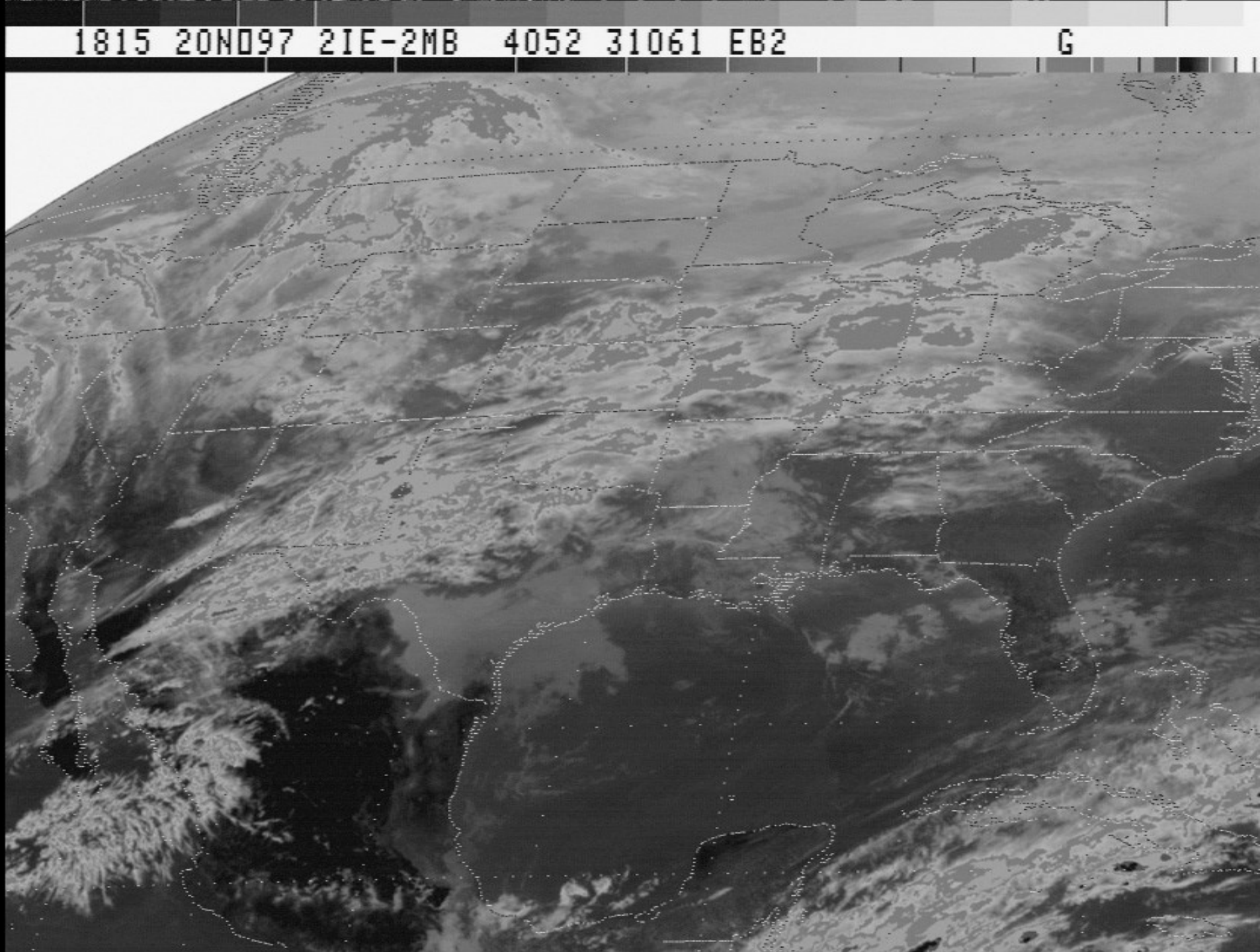
- Cloud organization terminology
  - Cloud type - a form of cloud (stratocumulus, cirrus)
  - Cloud element - smallest cloud seen on an image
  - Cloud fingers - narrow cloud bands; result of low-level convergence
  - Cloud lines and streets - continuous cloud formations; lines are connected, while streets are not
  - Cloud shield - a large, extensive area of clouds

Cloud Identification

- Cloud types
  - Low clouds
    - Fog and Stratus
      - General appearance
        - » Appearance on VIS - white to light gray, in a uniform sheet with little texture
        - » Appearance on IR - dark gray shade with little contrast between the clouds and the land since they are about the same temperature


Fog


1845 20ND97 1IB-2 4052 31061 EB2 G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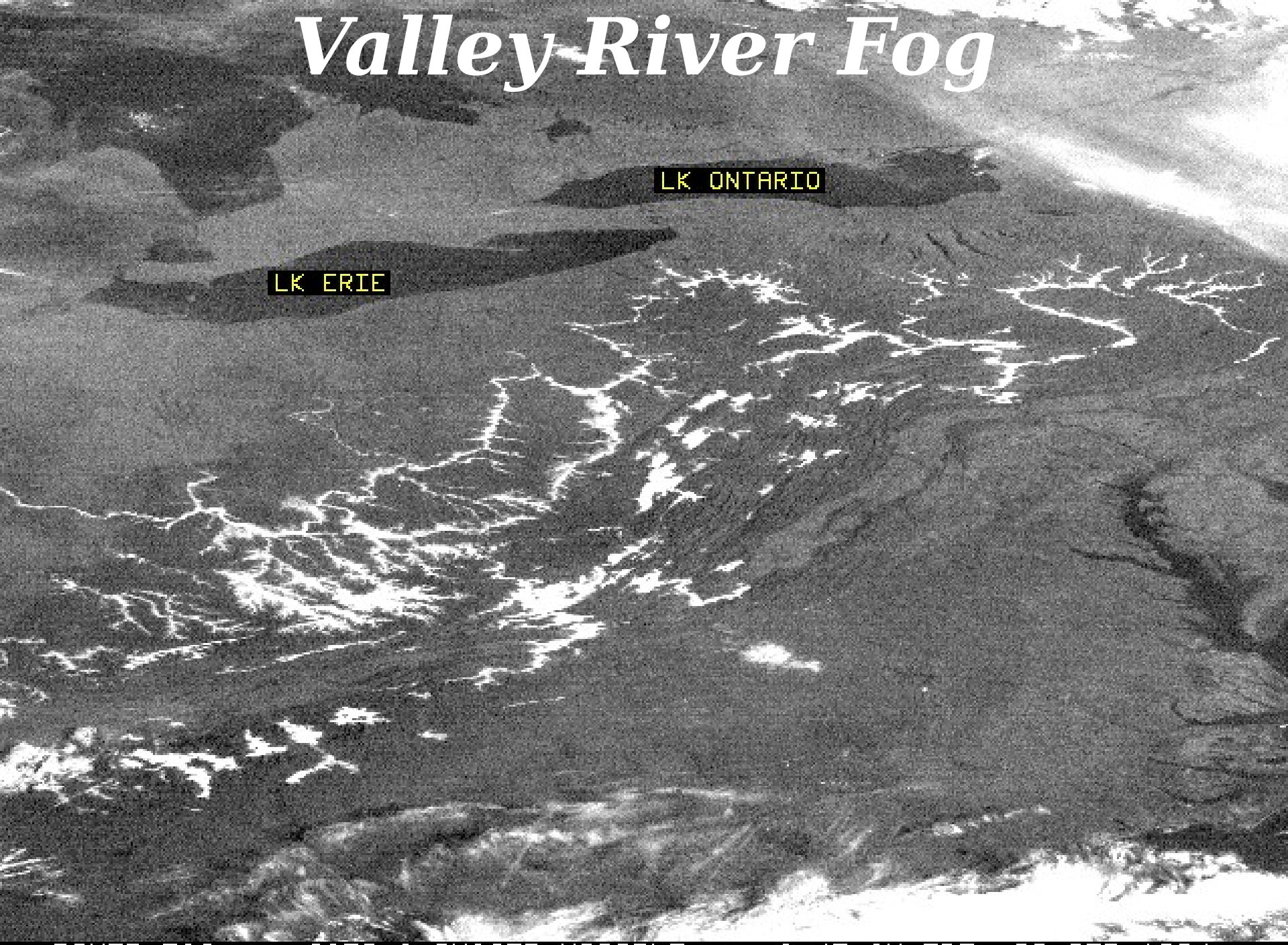
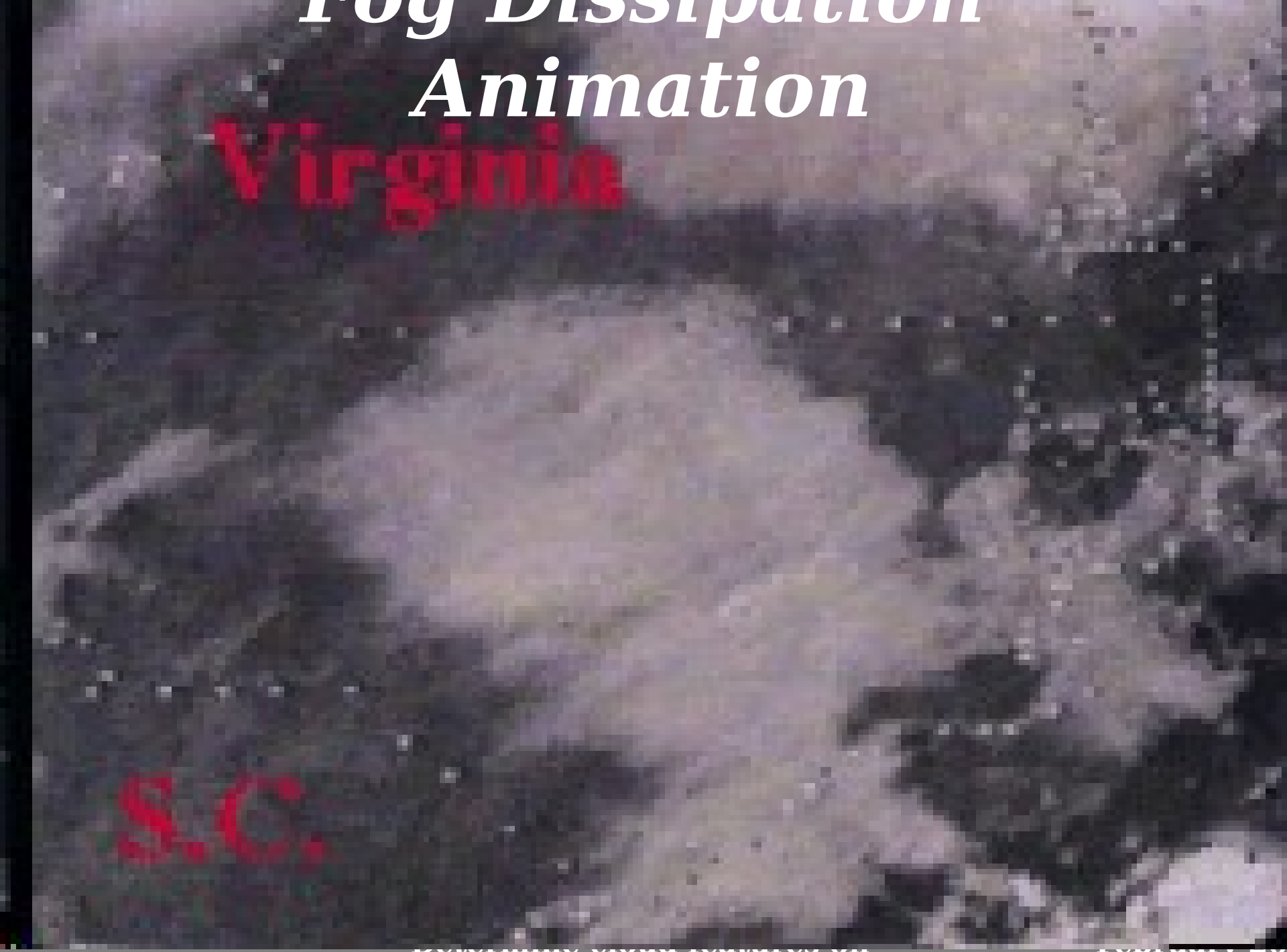
Valley River Fog



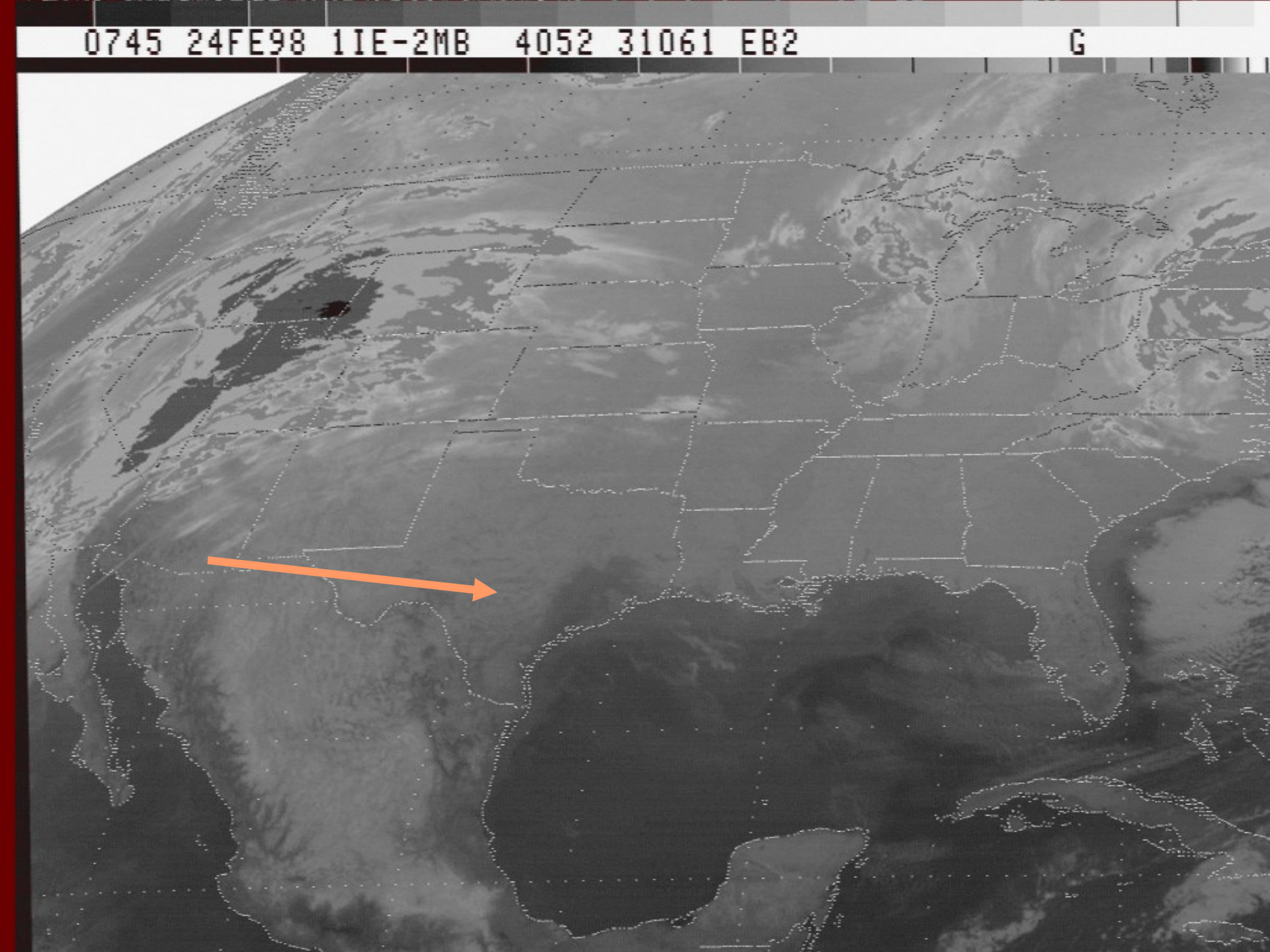
RIVER FOG - GOES-8 IMAGER VISIBLE - 8:45 AM EDT 20 SEP 1994


Fog Dissipation
Animation
Virginia
S.C.

Cloud Identification

- Fog/stratus occasionally forms under i nversion at night, resulting in “black stratus”.

Black Stratus Animation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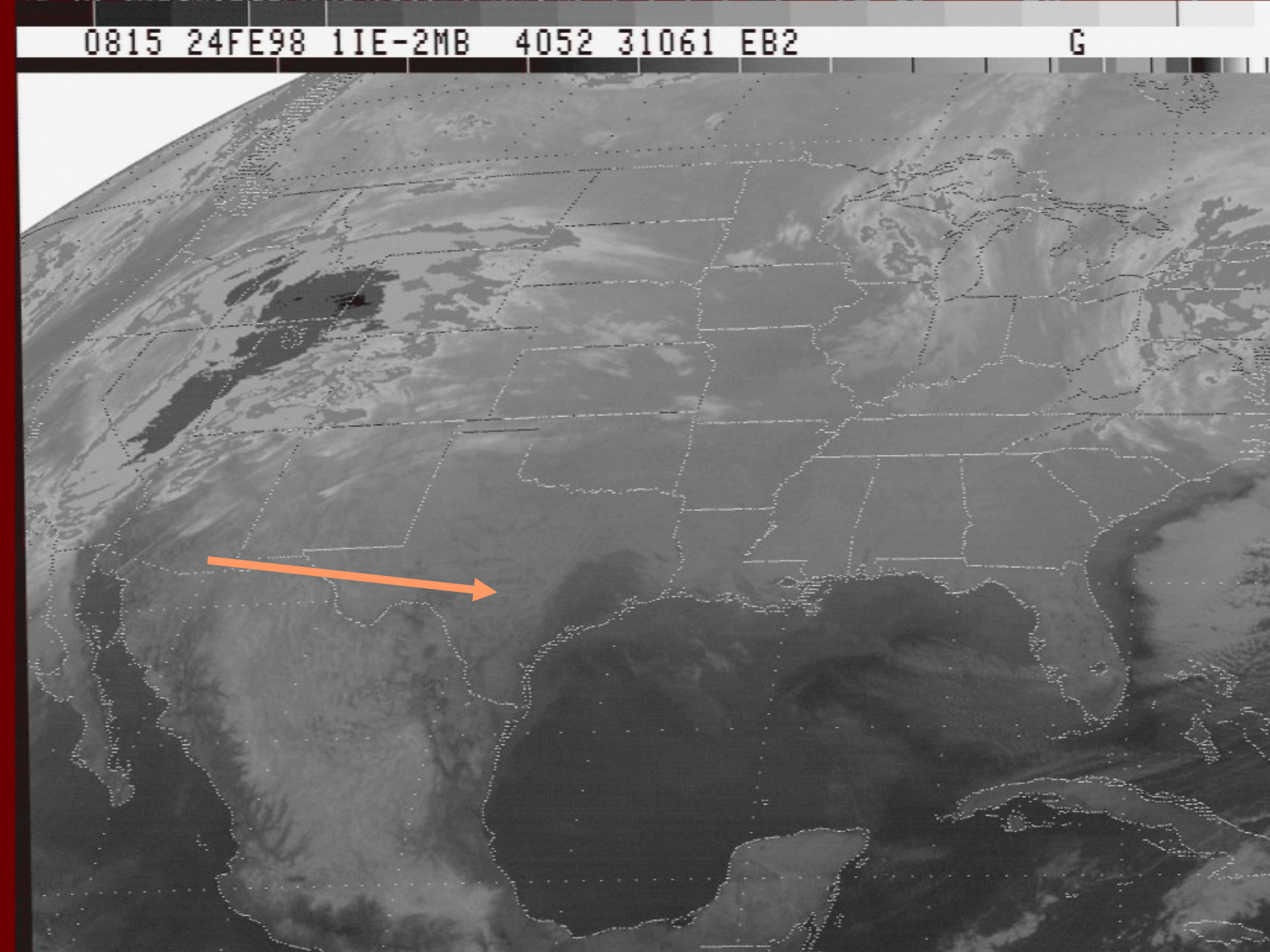
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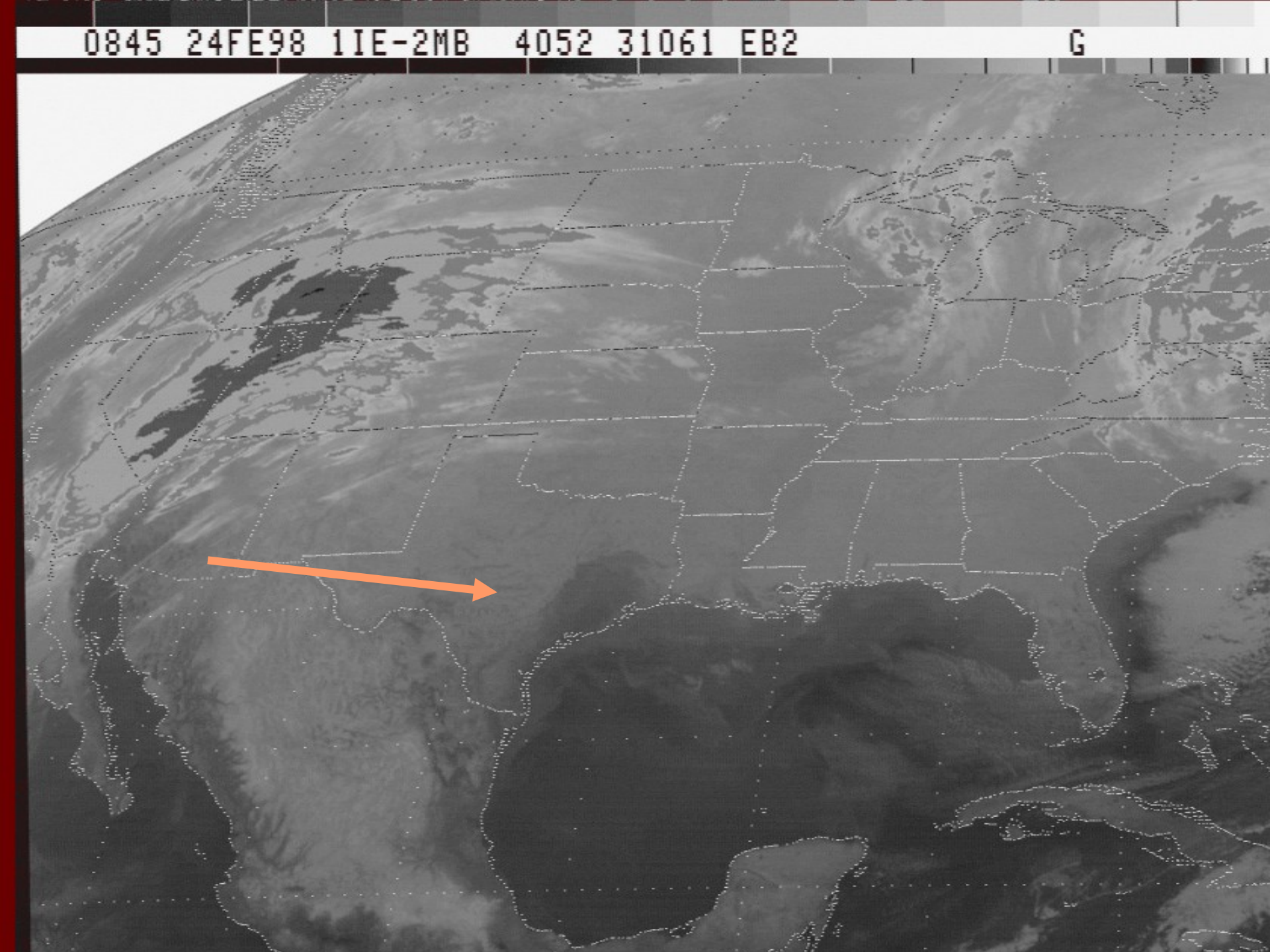
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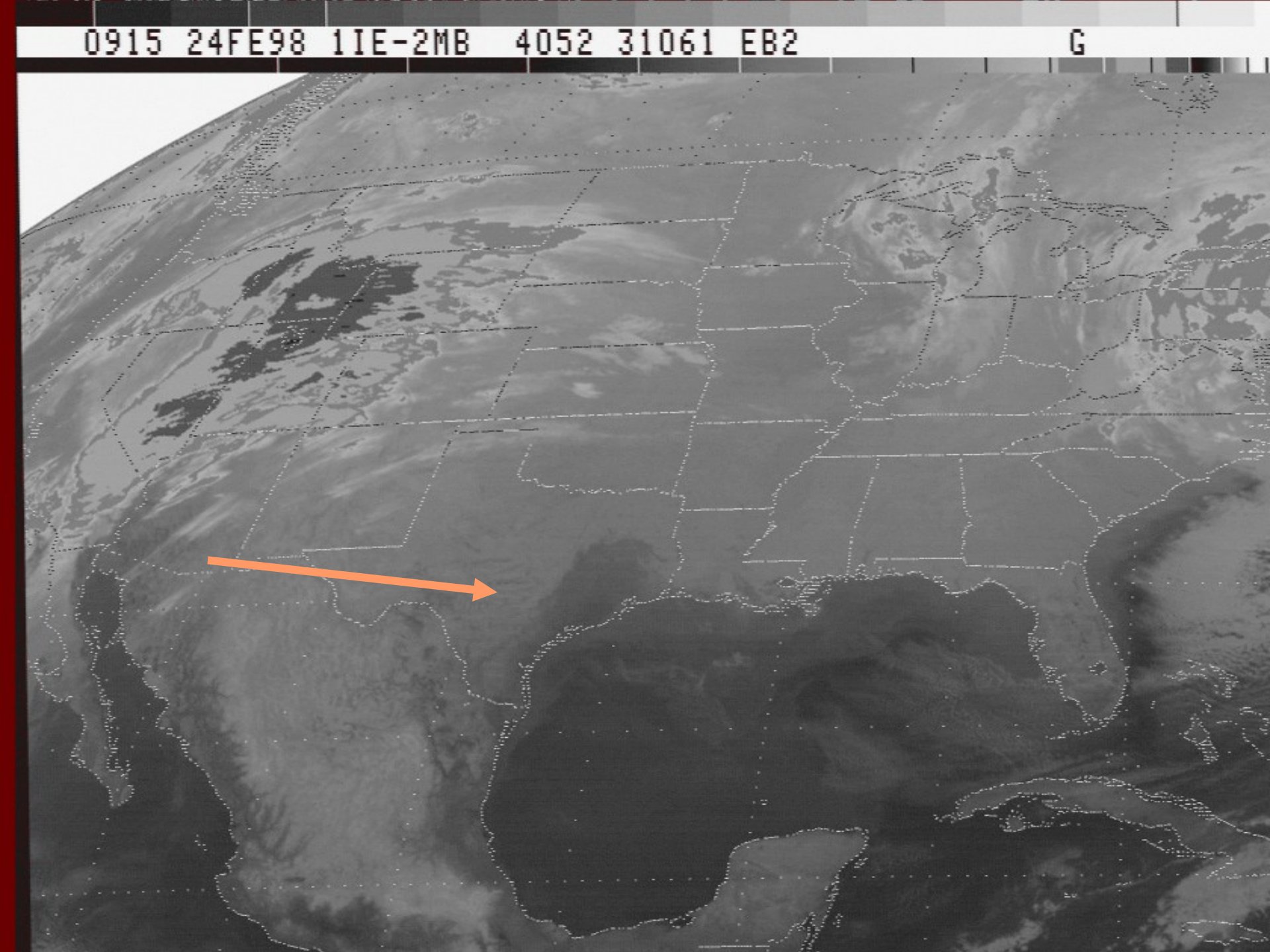
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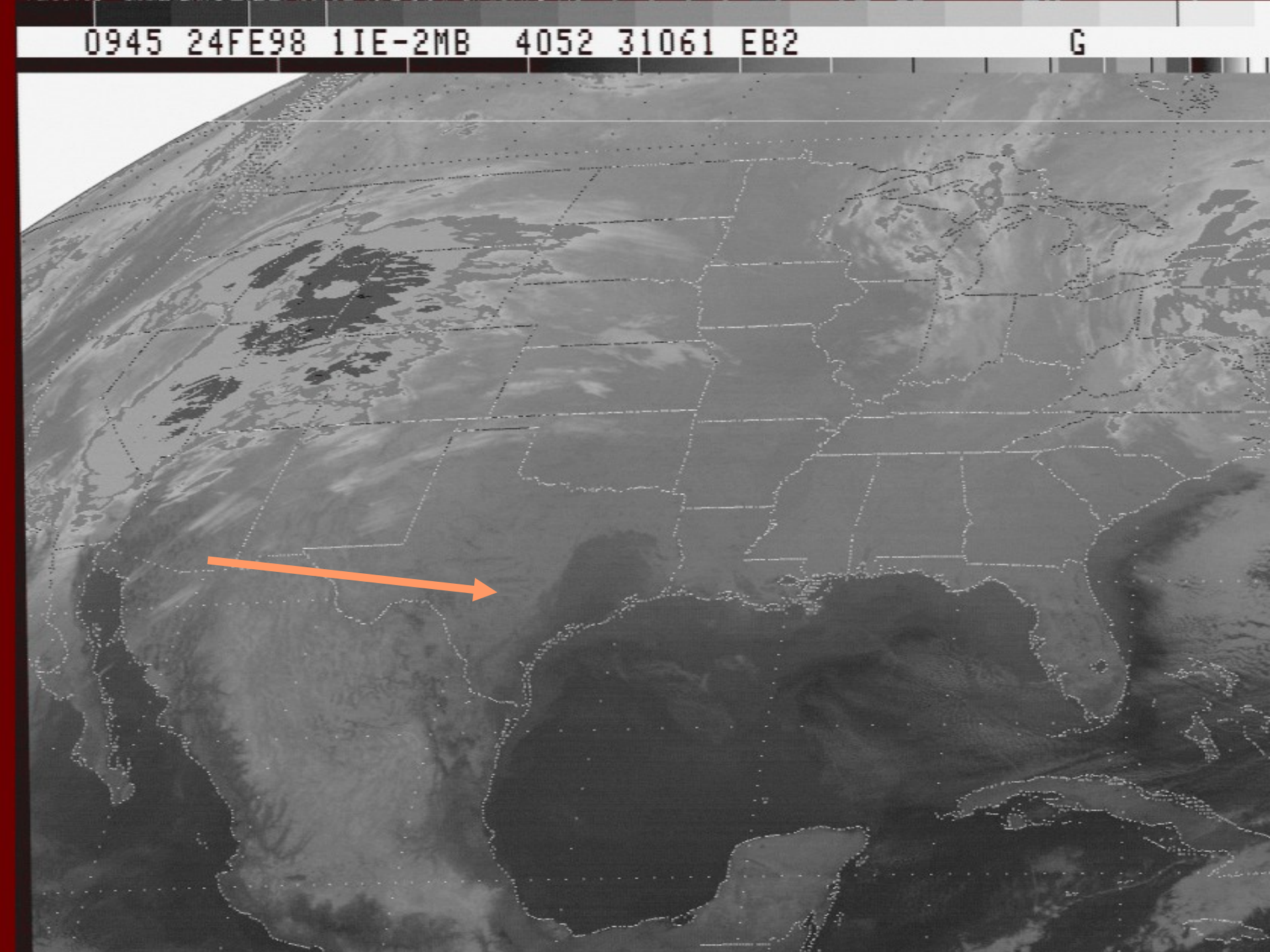
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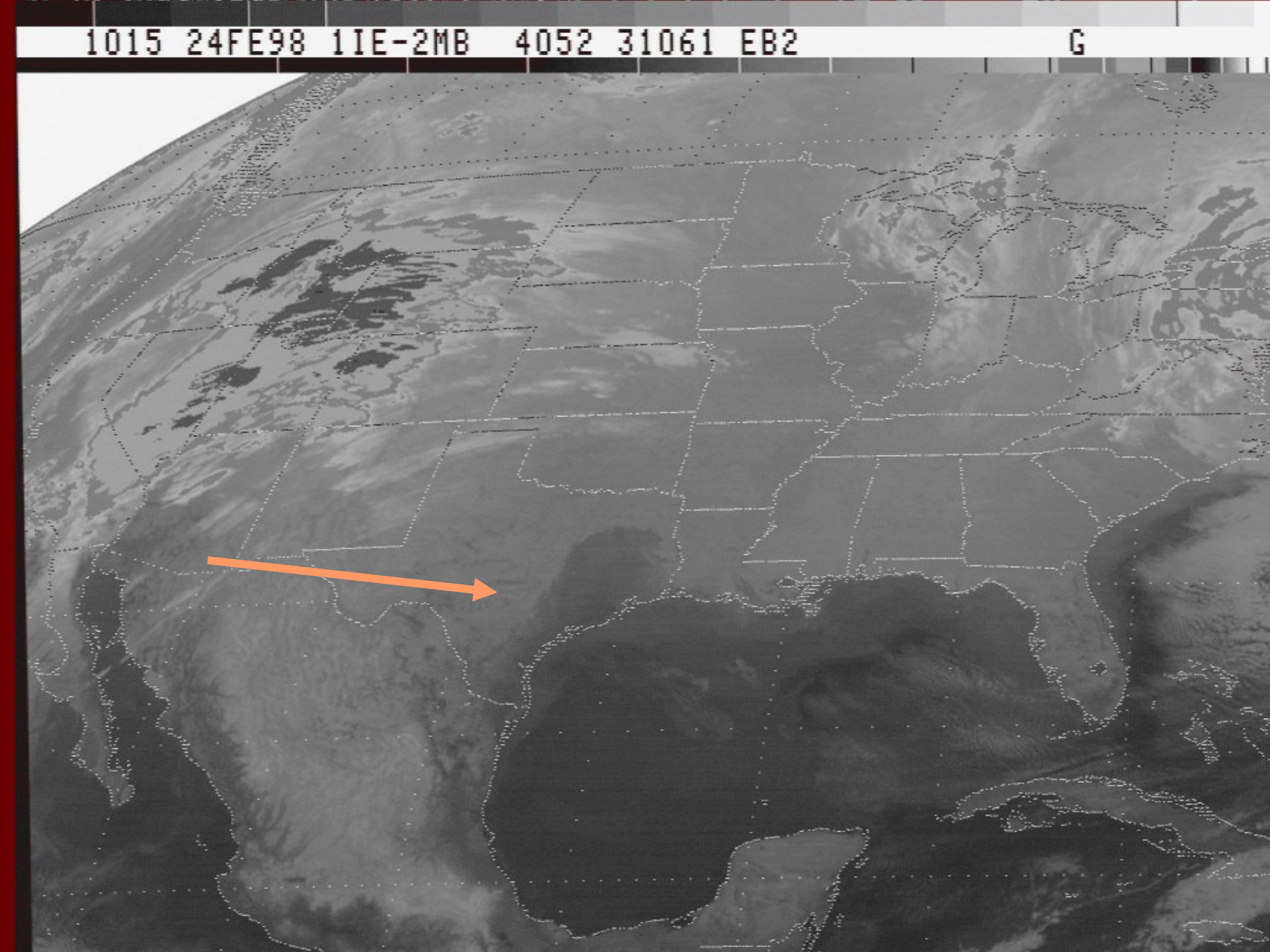
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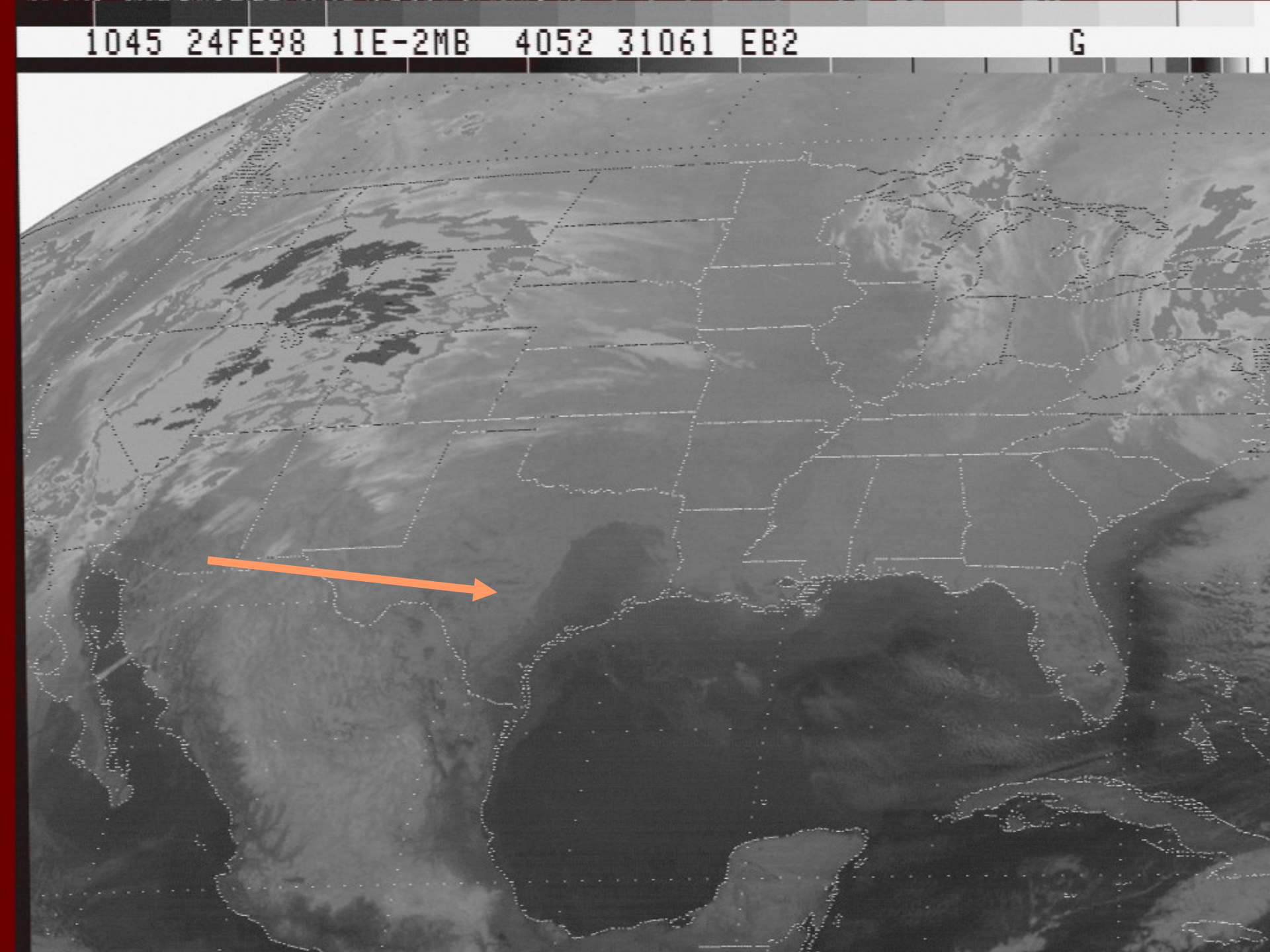
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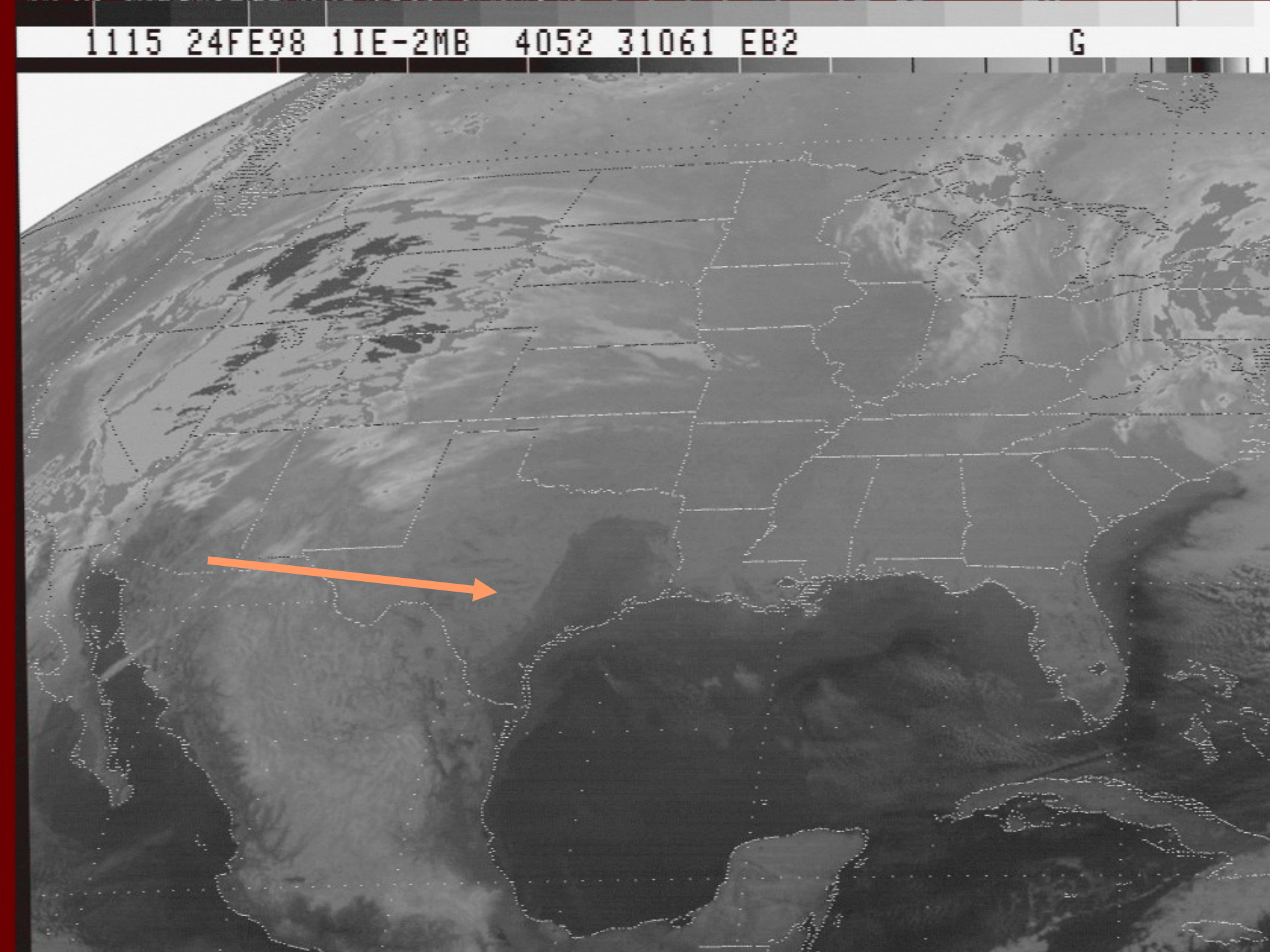
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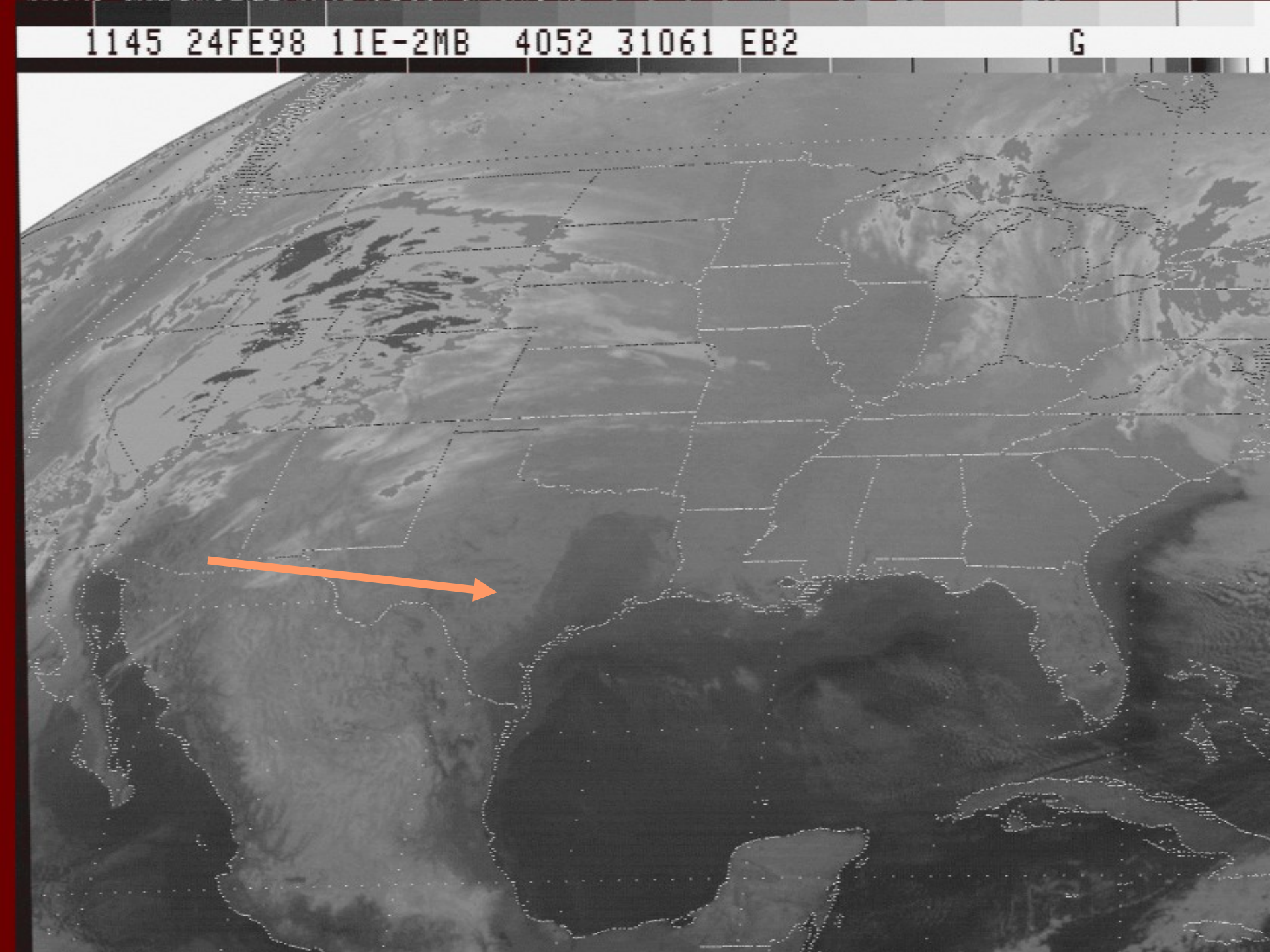
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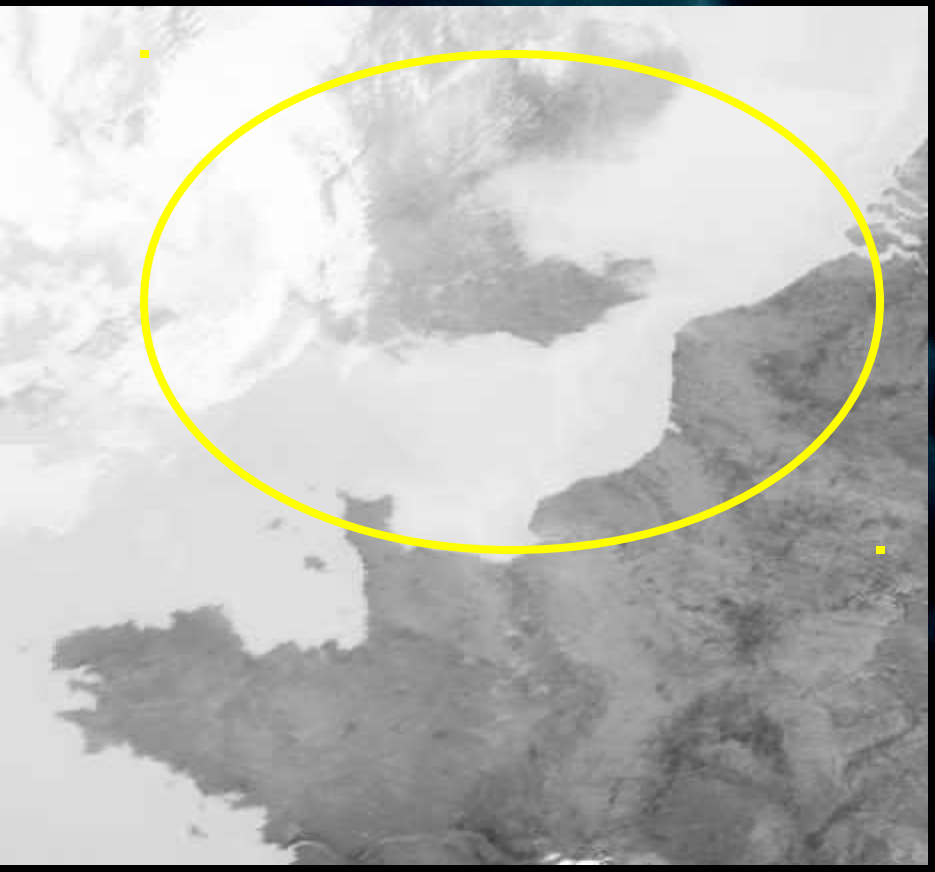
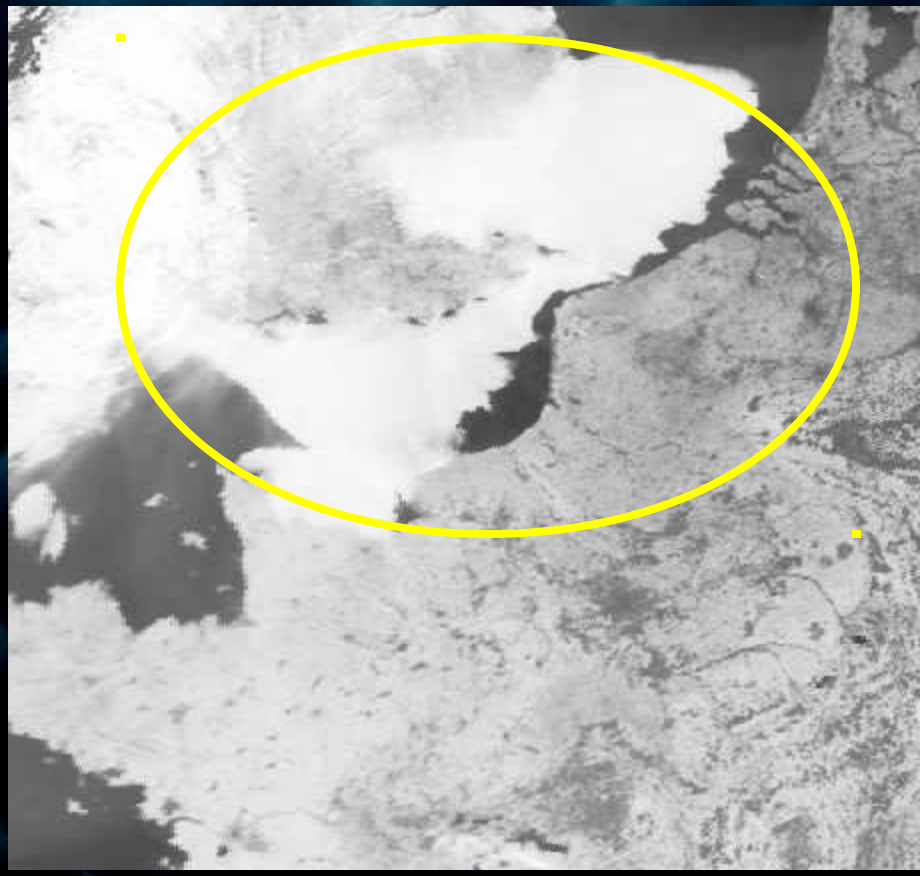
Stratus (ST)





IR

VIS

Determine cloud features on February 20

Cloud Identification

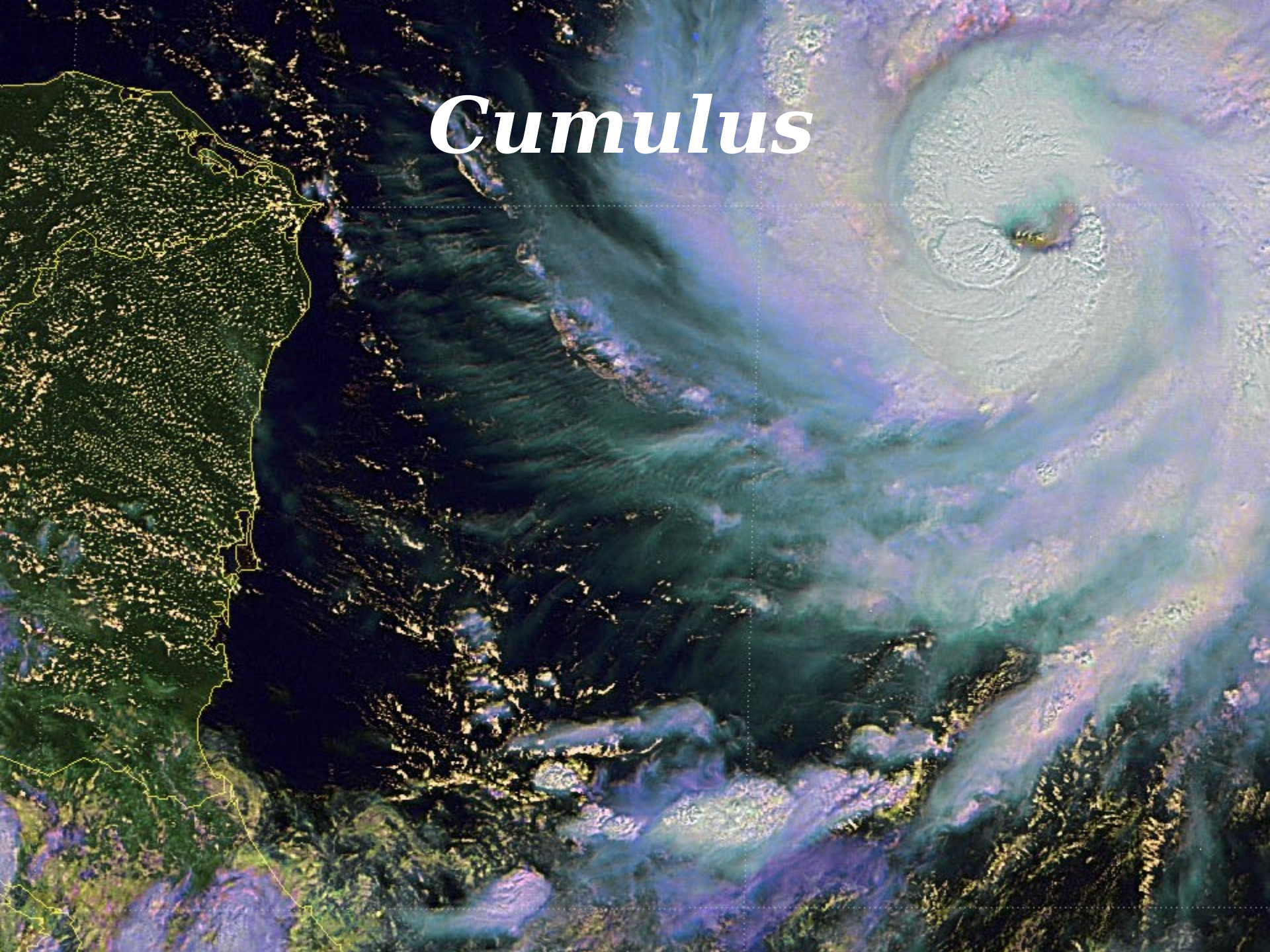
- Stratocumulus
  - Appearance on VIS - light gray to white, with a textured appearance
  - Appearance on IR - dark gray, indicating warm temperatures

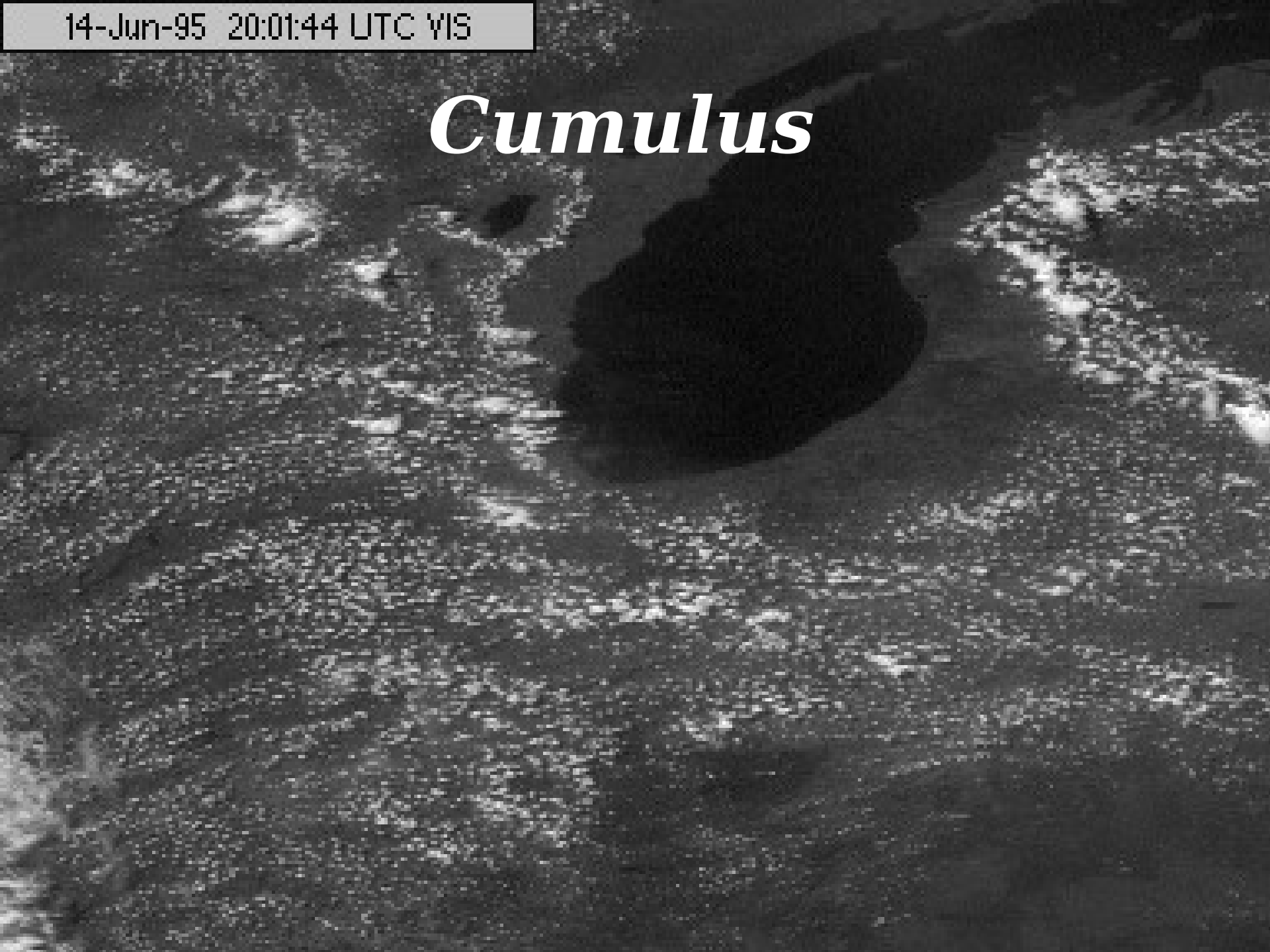
Stratocumulus

Stratocumulus

Cloud Identification

- Cumulus
  - Appearance on VIS
    - A small, white cloud usually seen as a field of unorganized "popcorn" cumulus
    - A field of cumulus may appear as a uniform light gray shade because of contamination
  - Appearance on IR
    - Individual elements are usually NOT discernible since they are smaller than the resolution of the IR sensor
    - Large concentrated areas of cumulus are discernible, and they appear as a dark gray since the cloud temperature is averaged with the warmer temperature of the underlying surface around the clouds


Cumulus

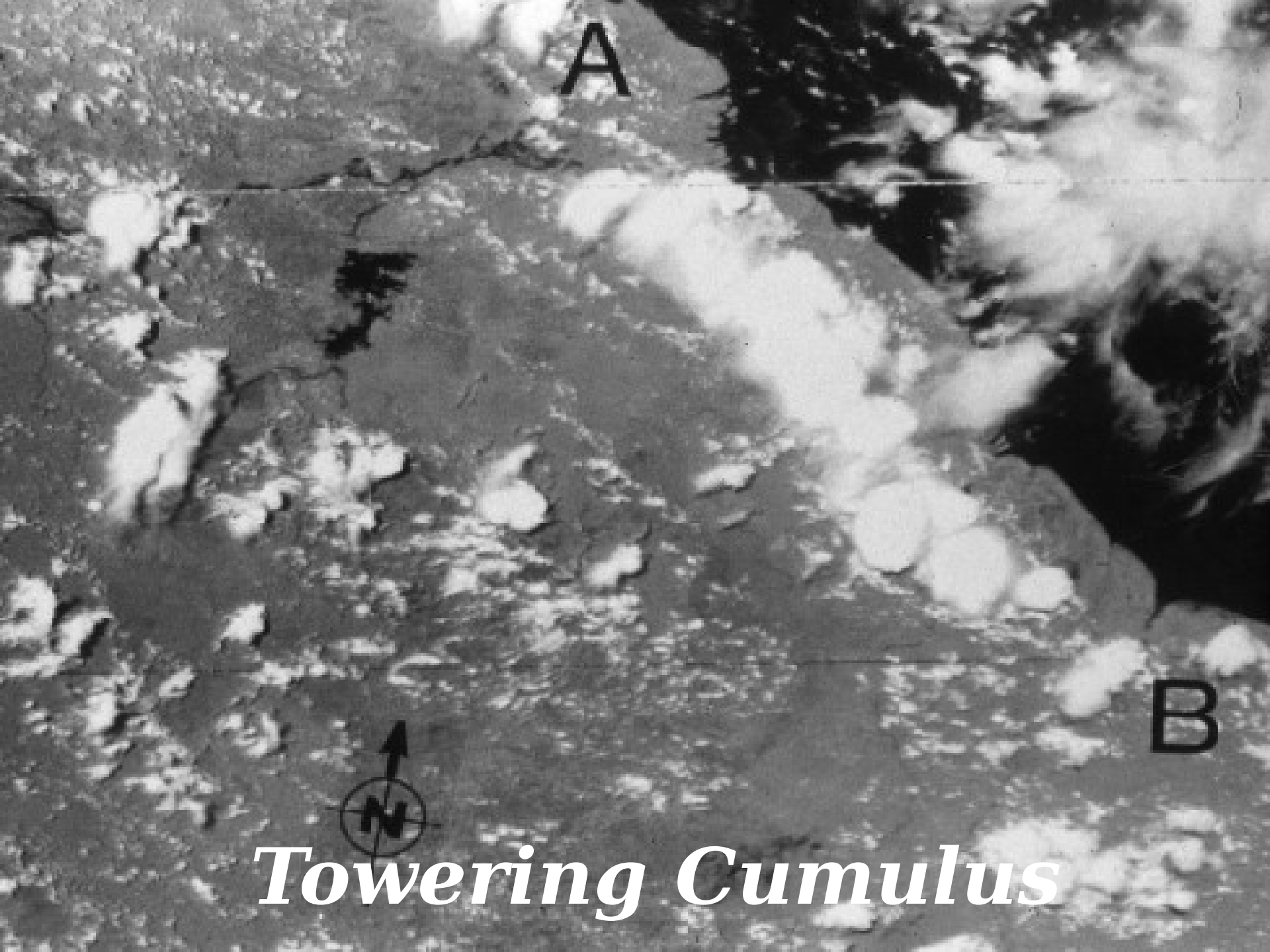

14-Jun-95 20:01:44 UTC VIS
Cumulus

Cumulus

Cumulus

Cloud Identification

- Towering Cumulus
  - Appearance on VIS - towering cumulus are circular clouds which appear light gray to bright white
  - Appearance on IR - light gray
    - They are lighter than cumulus
    - On MB enhanced imagery, cloud tops may be cold enough to be contoured



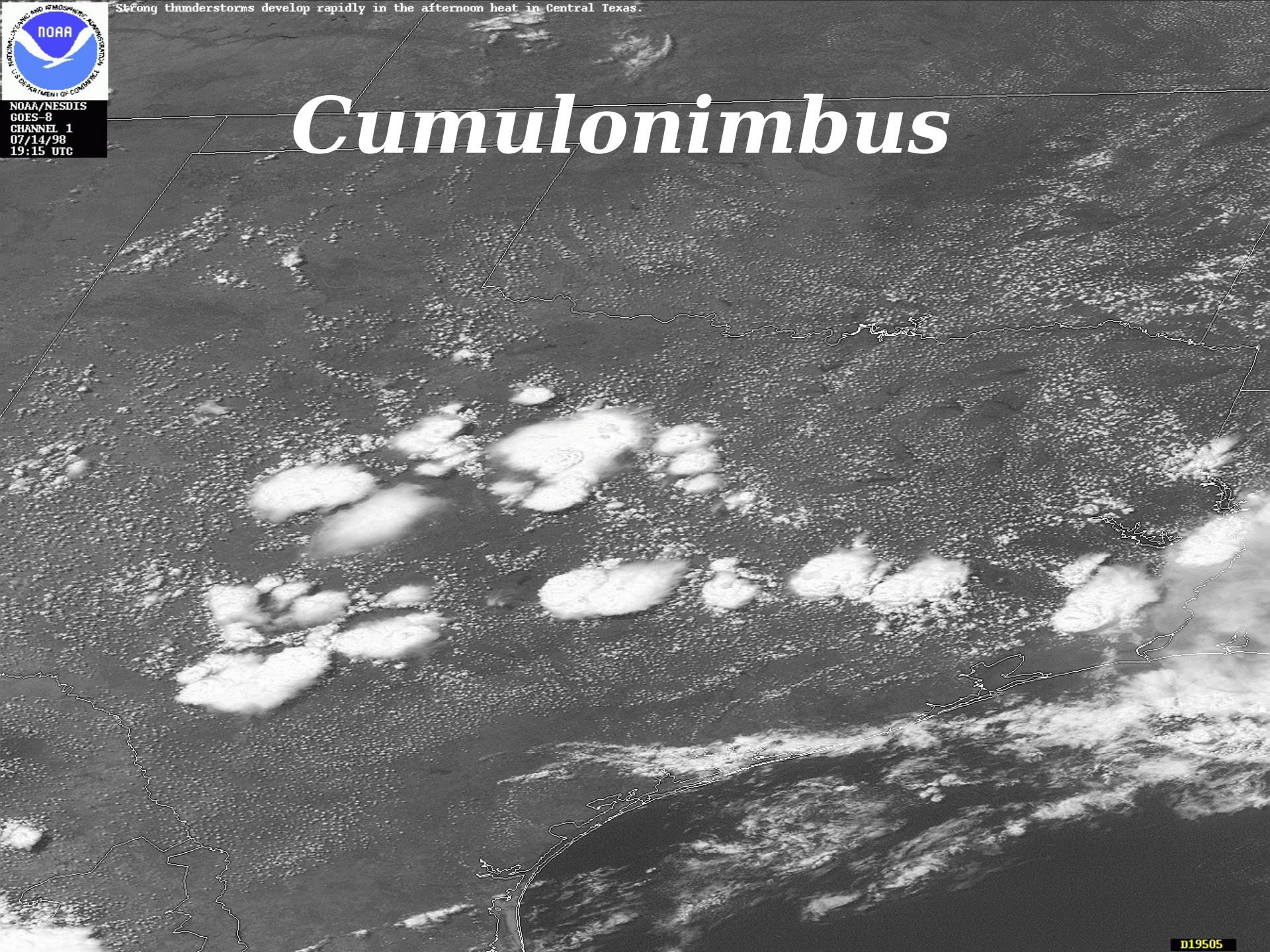
Towering Cumulus

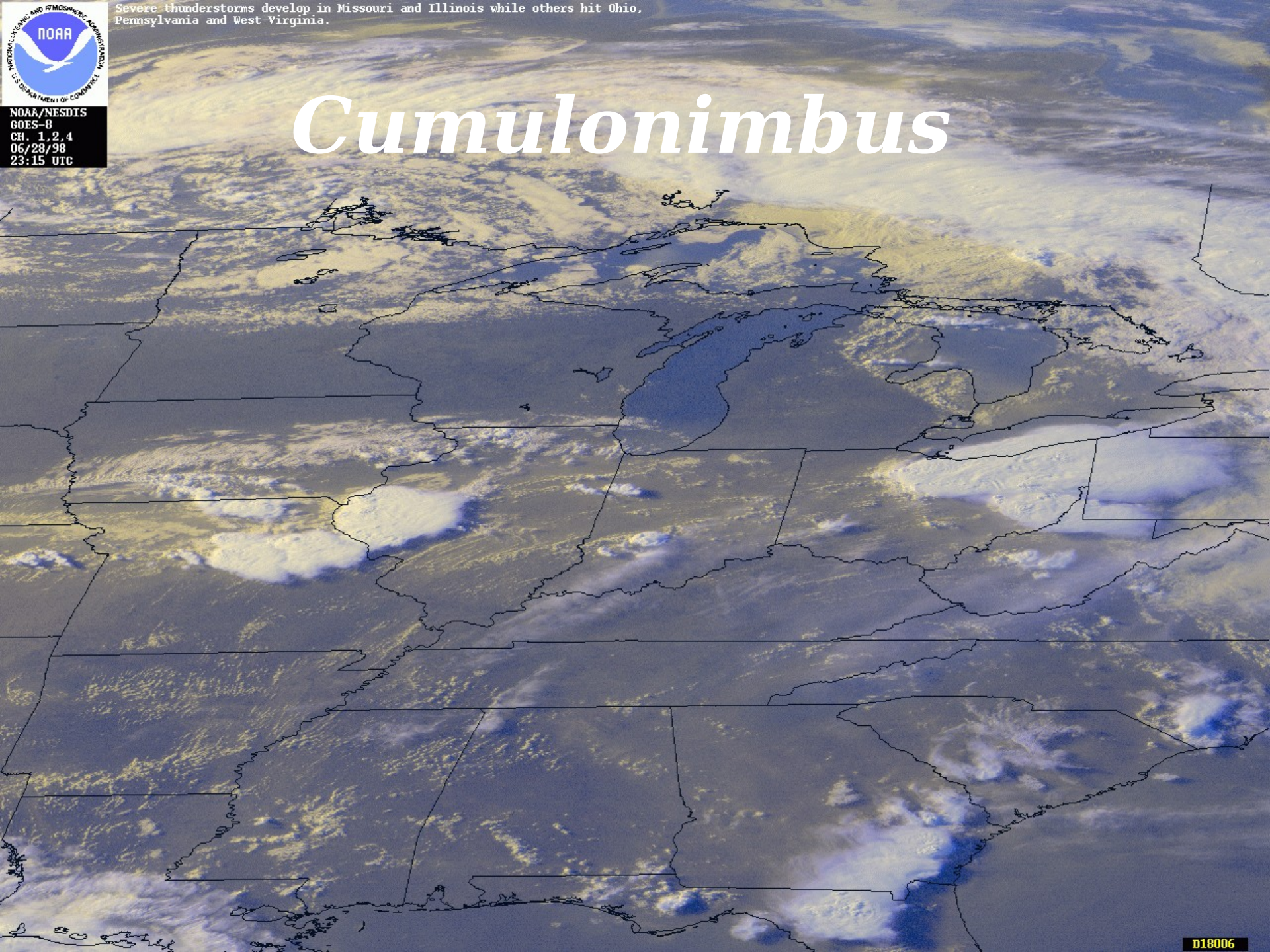
Cloud Identification

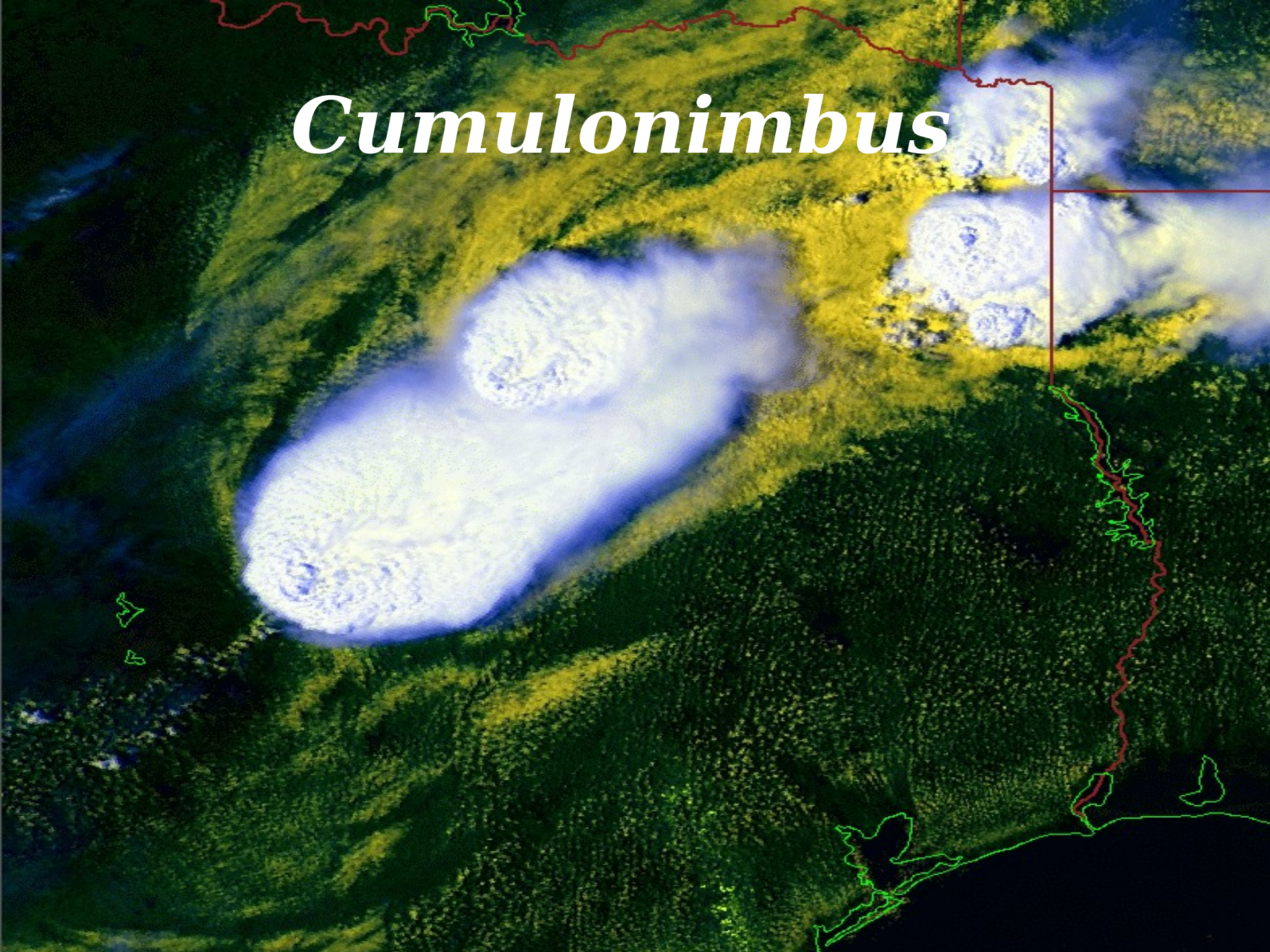
- Cumulonimbus
  - Appearance on VIS - bright white with a round or elongated anvil plume
    - They have a sharp upstream cloud edge and a thin, diffuse anvil that spreads out downstream.
    - Individual updraft cells known as overshooting tops are sometimes visible as a bulge above the otherwise smooth anvil top.
    - This is an indication of possible severe weather.
    - Cumulonimbus clouds may also cast shadows on lower cloud decks if the sun angle is low.

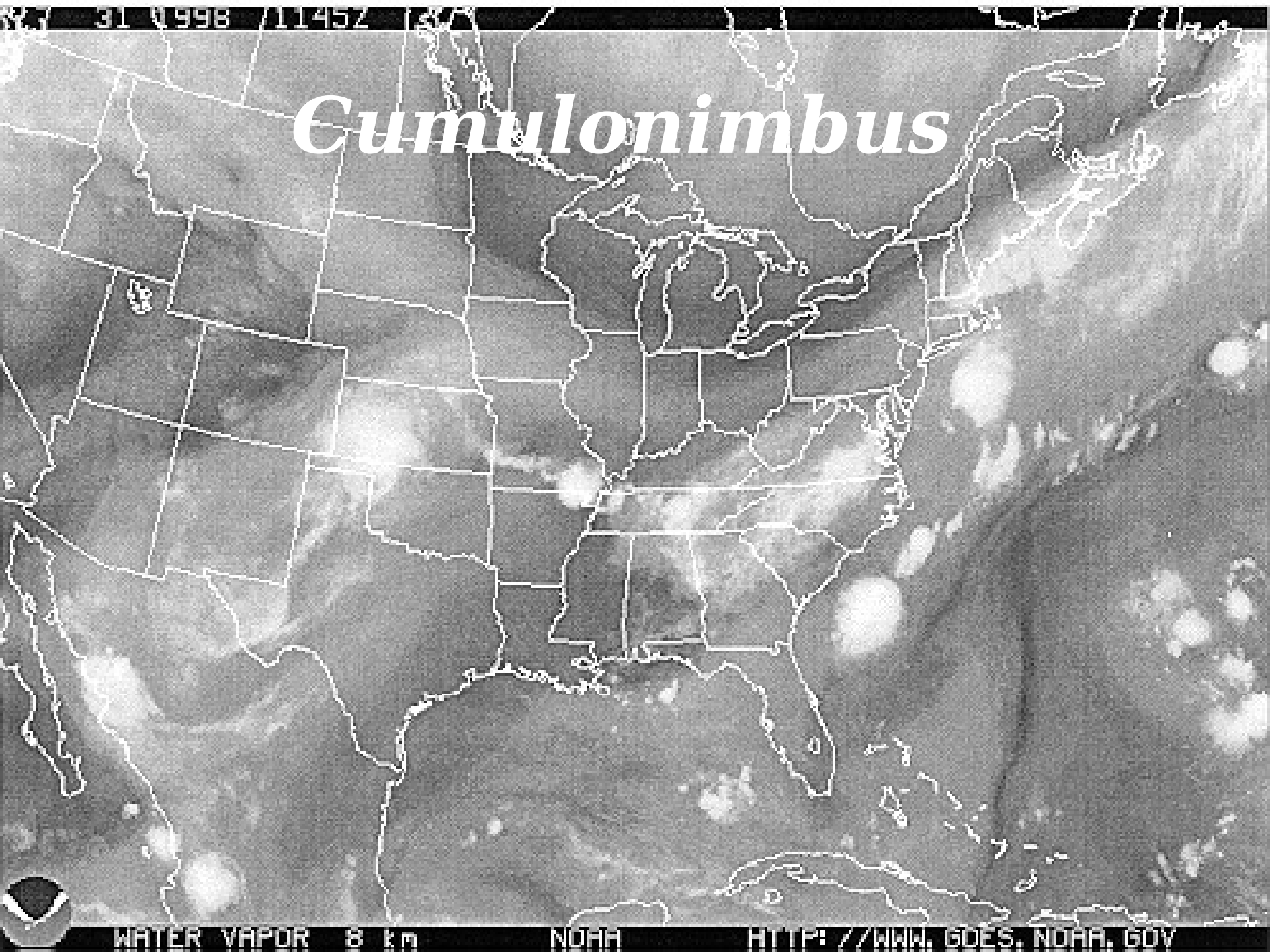
Cloud Identification

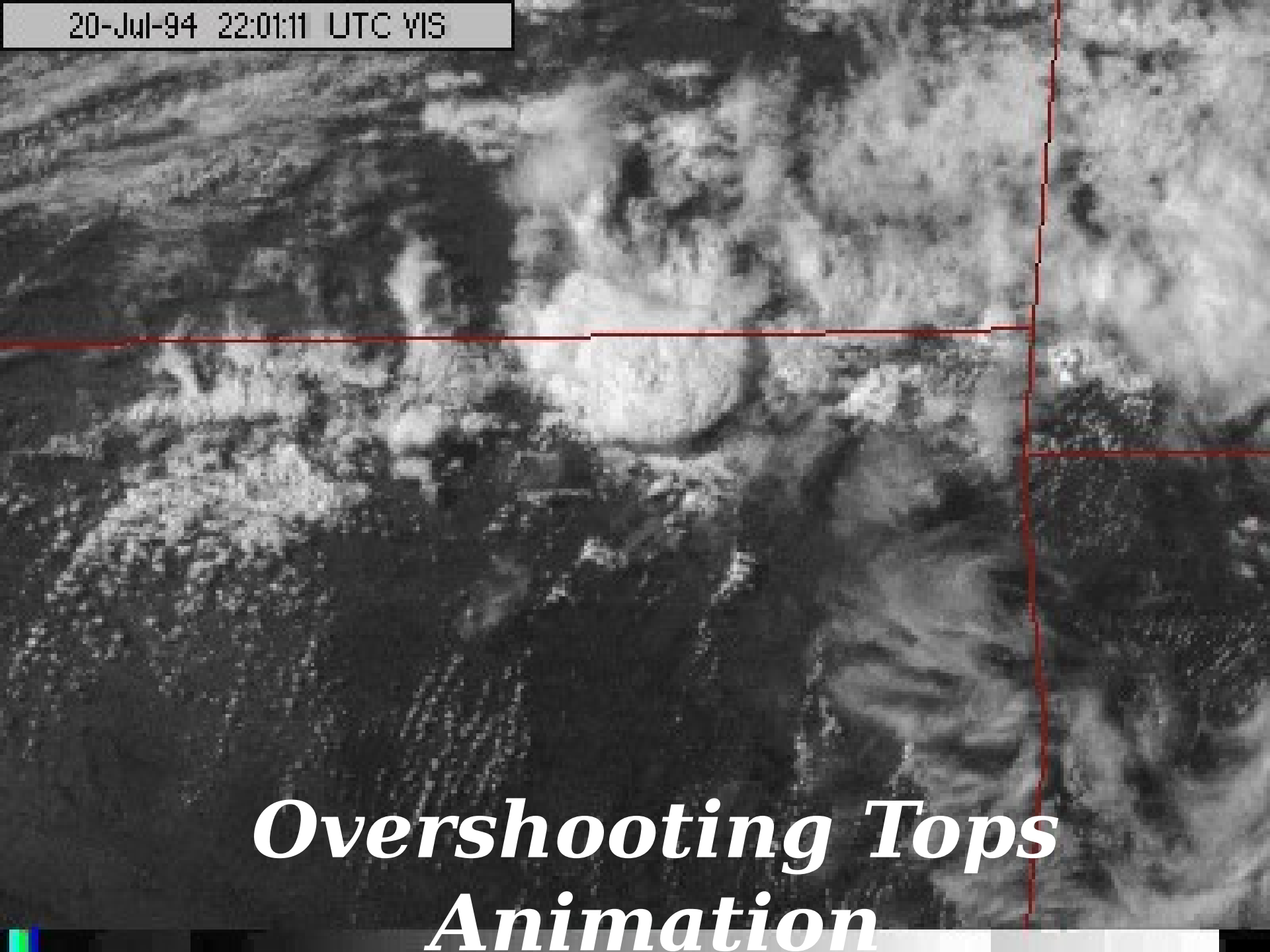
- Appearance on IR - bright white on unenhanced imagery, highly enhanced by most other enhancement curves.
- Appearance on WV - bright white area in a region of darker shades and cumulonimbus normally brightest features on water vapor imagery.


Strong thunderstorms develop rapidly in the afternoon heat in Central Texas.
NOAA/NESDIS
GOES-8
CHANNEL 1
07/14/98
19:15 UTC
Cumulonimbus
D19505


Severe thunderstorms develop in Missouri and Illinois while others hit Ohio, Pennsylvania and West Virginia.
NOAA/NESDIS
GOES-8
CH. 1,2,4
06/28/98
23:15 UTC
Cumulonimbus
D18006


Cumulonimbus

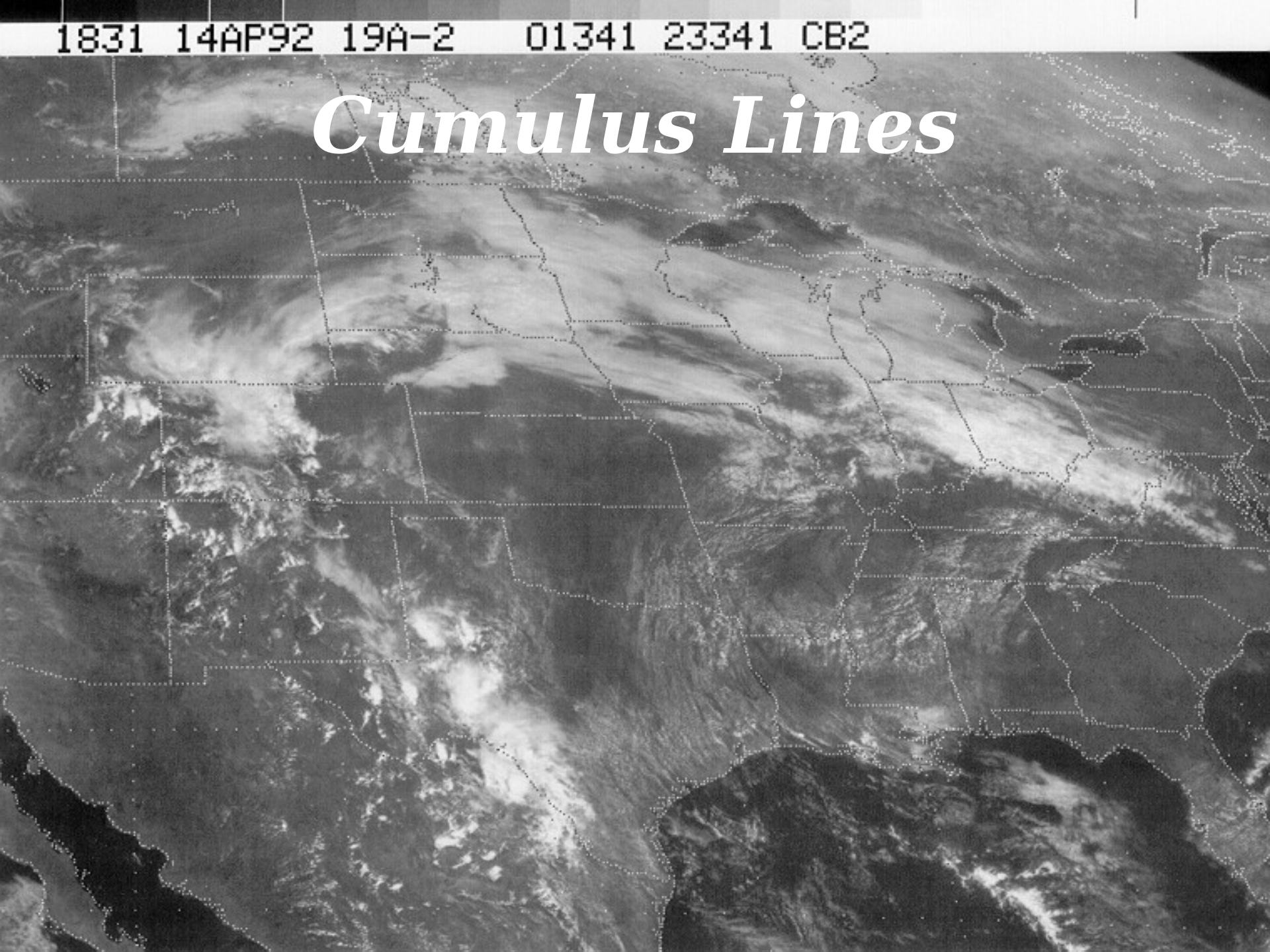

31 1998 /1145Z
Cumulonimbus
WATER VAPOR 8 km
NOAA
HTTP://WWW.GOES.NOAA.GOV



Overshooting Tops Animation

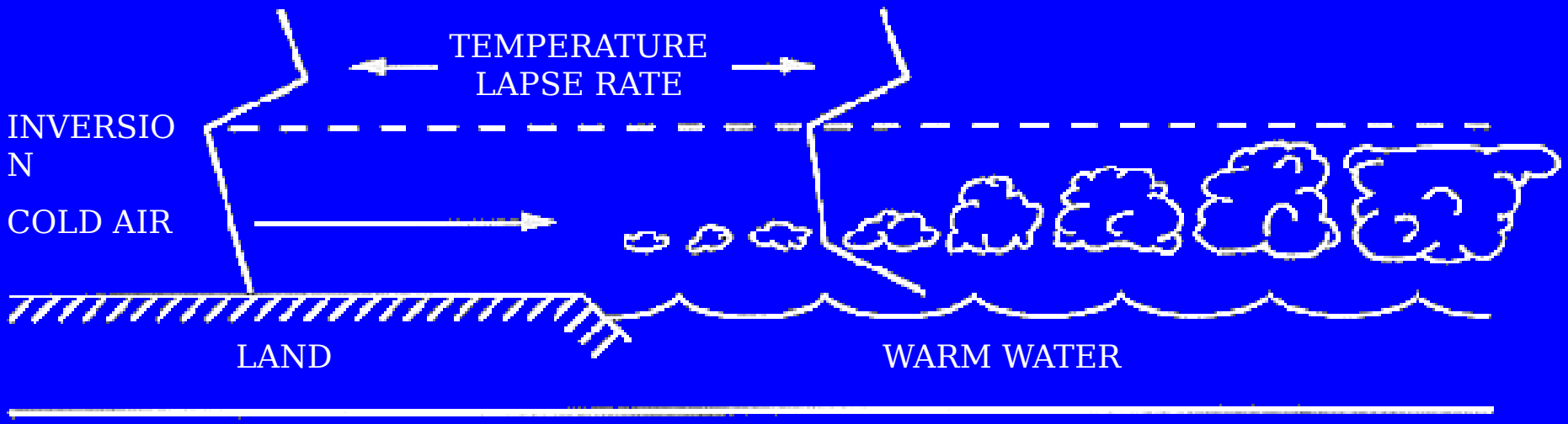
Cloud Identification

- Special types of low cloud organizations
  - Cumulus lines/streets - cumulus organized into lines and streets common with maritime air masses being heated over land.
  - Stratocumulus lines - develop as the air destabilizes due to surface heating and normally develop in regions of vertical wind she ar
    .
    - Appearance on VIS - light gray to white depending on the amount of contamination
      - Appearance on IR - medium to dark gray. Lines may/may not be identifiable depending on the sensor resolution

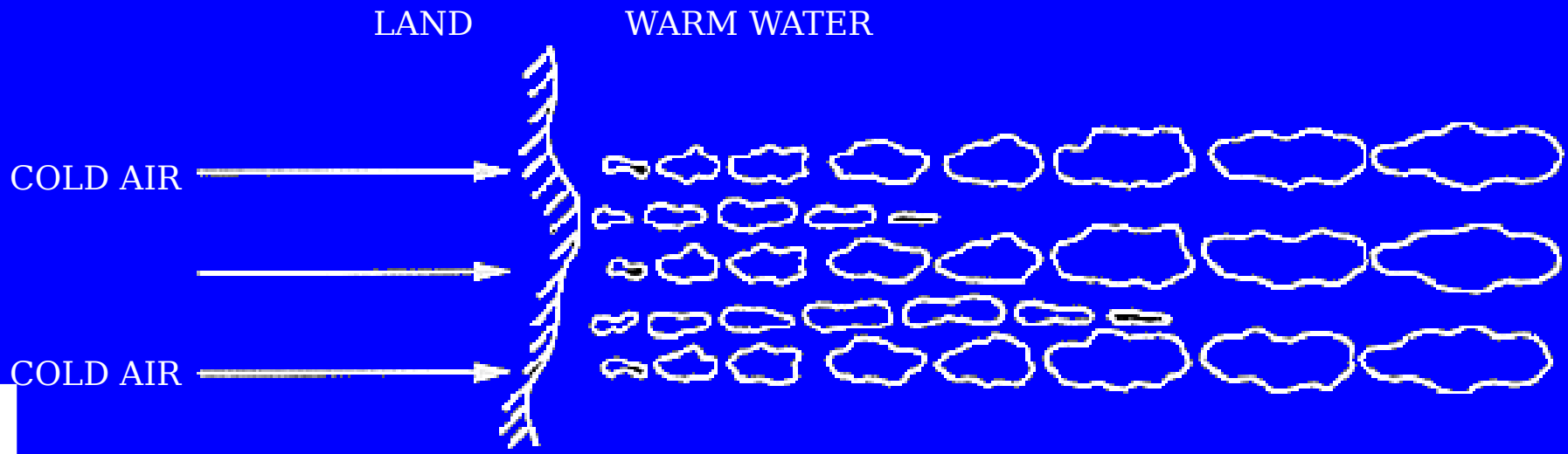

1831 14AP92 19A-2 01341 23341 CB2
Cumulus Lines

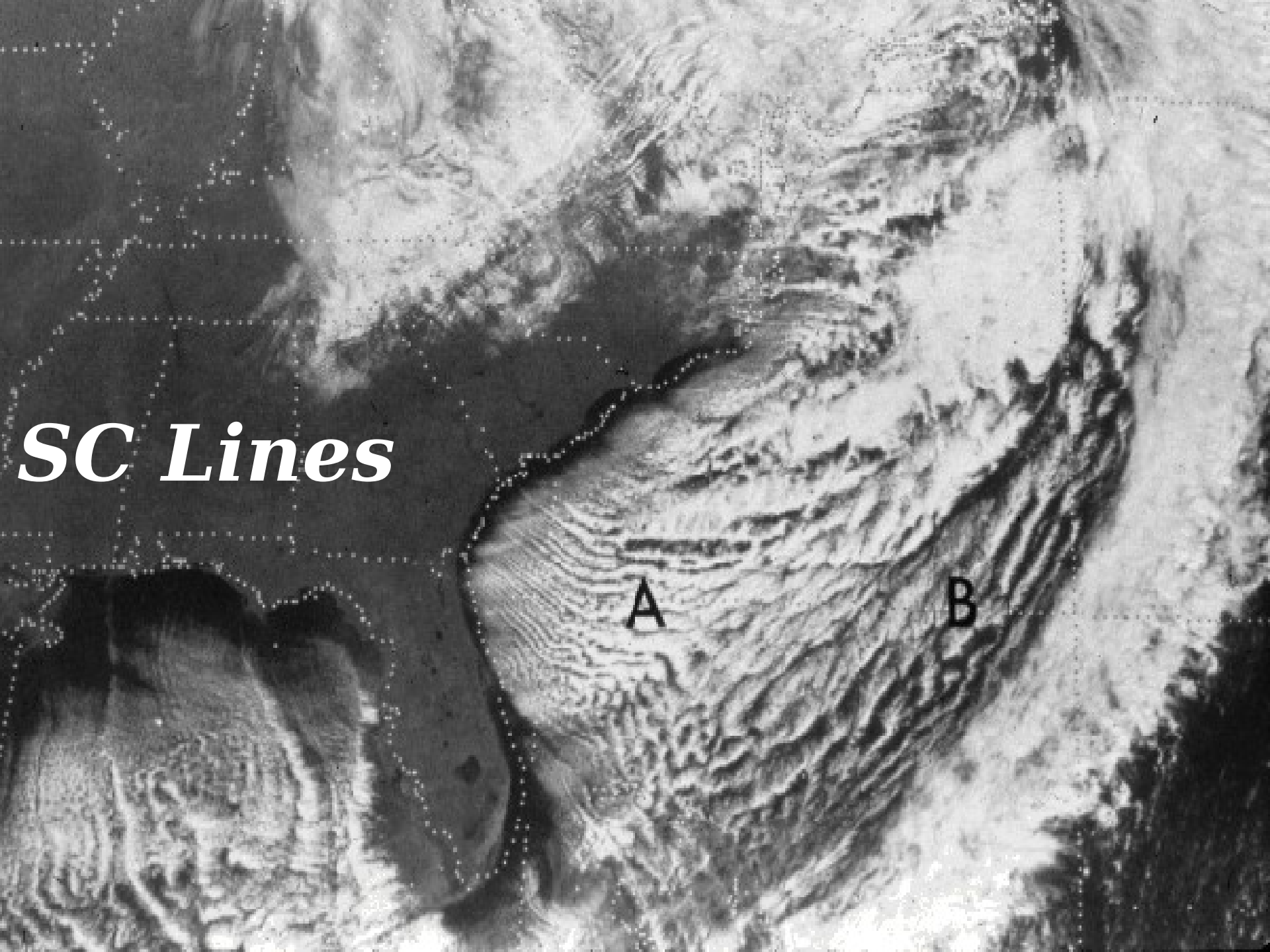
STRATOCUMULUS LINES

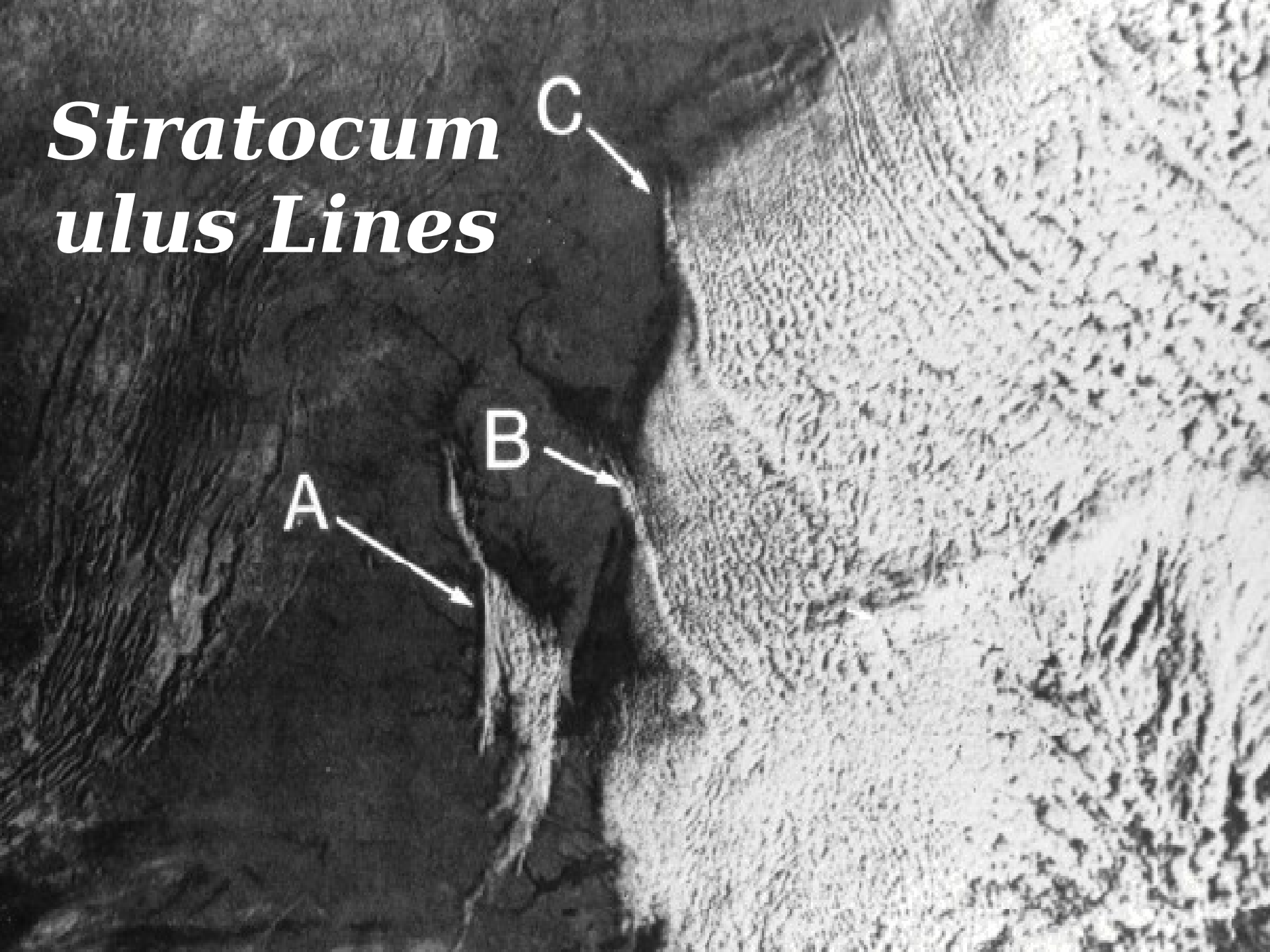
VIEW LOOKING HORIZONTALLY

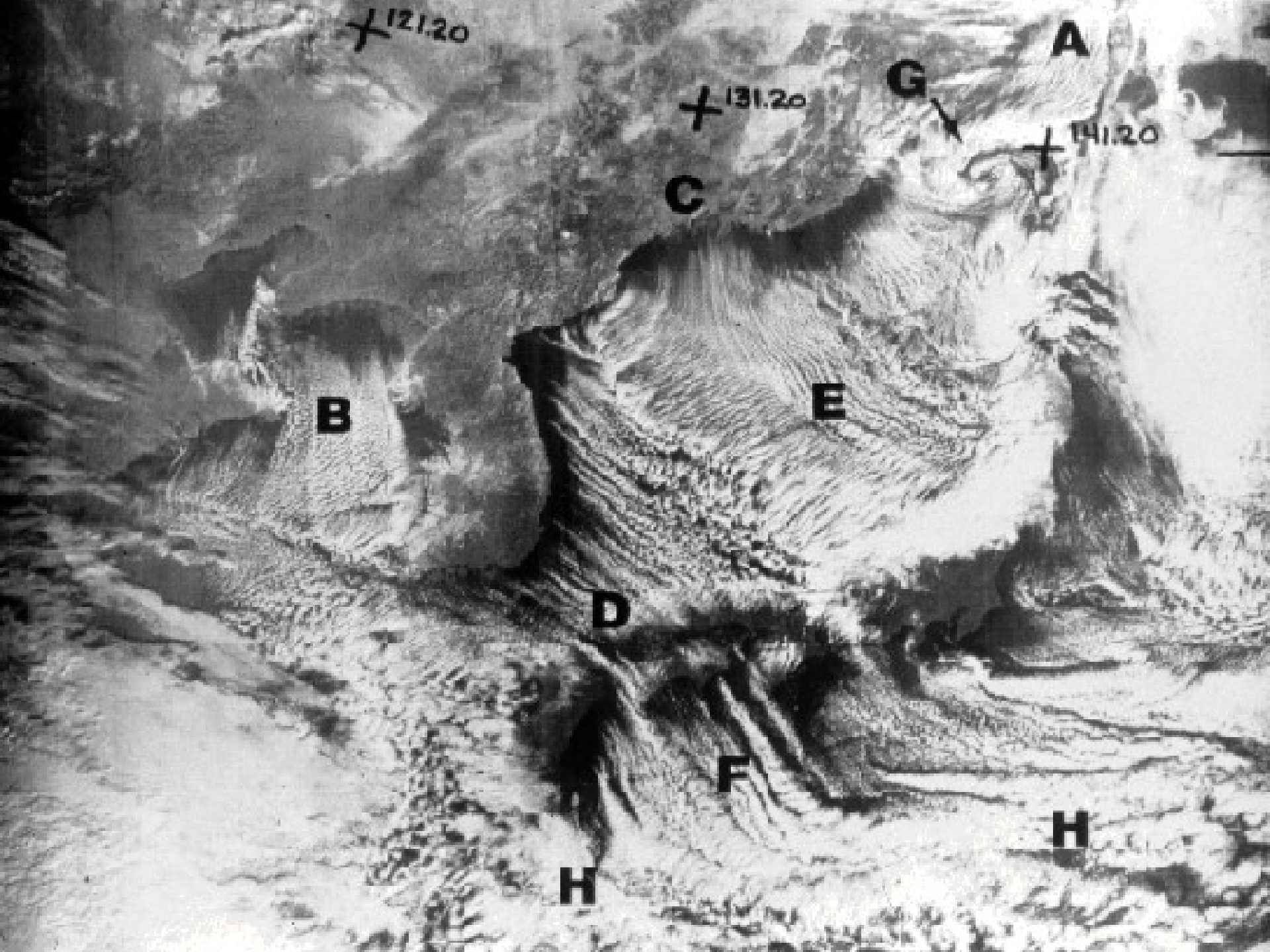


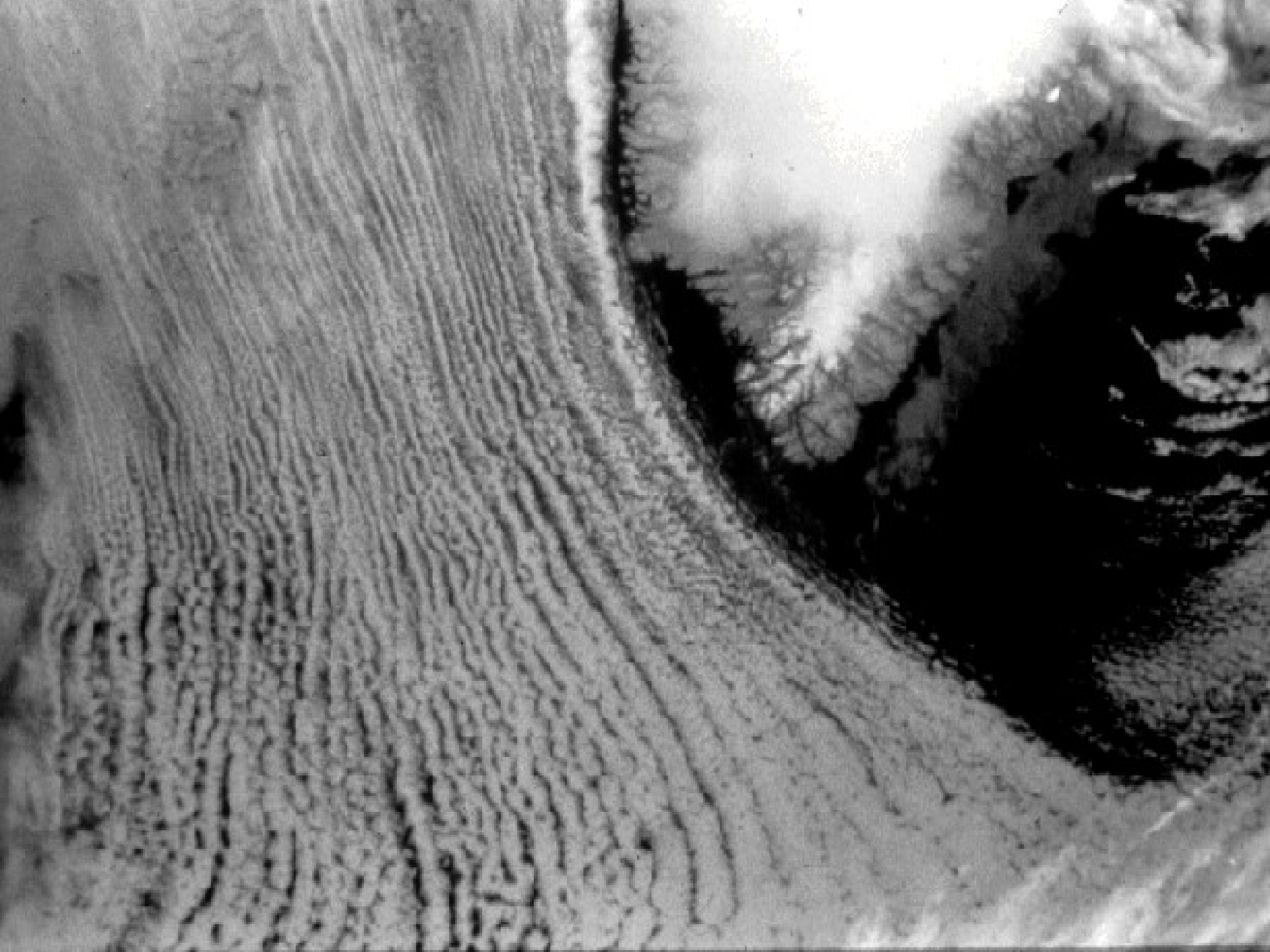
VIEW FROM ABOVE




SC Lines
A
B


Stratocum
ulus Lines
C
B
A


121.20
131.20
141.20
A
G
C
B
E
D
F
H
H

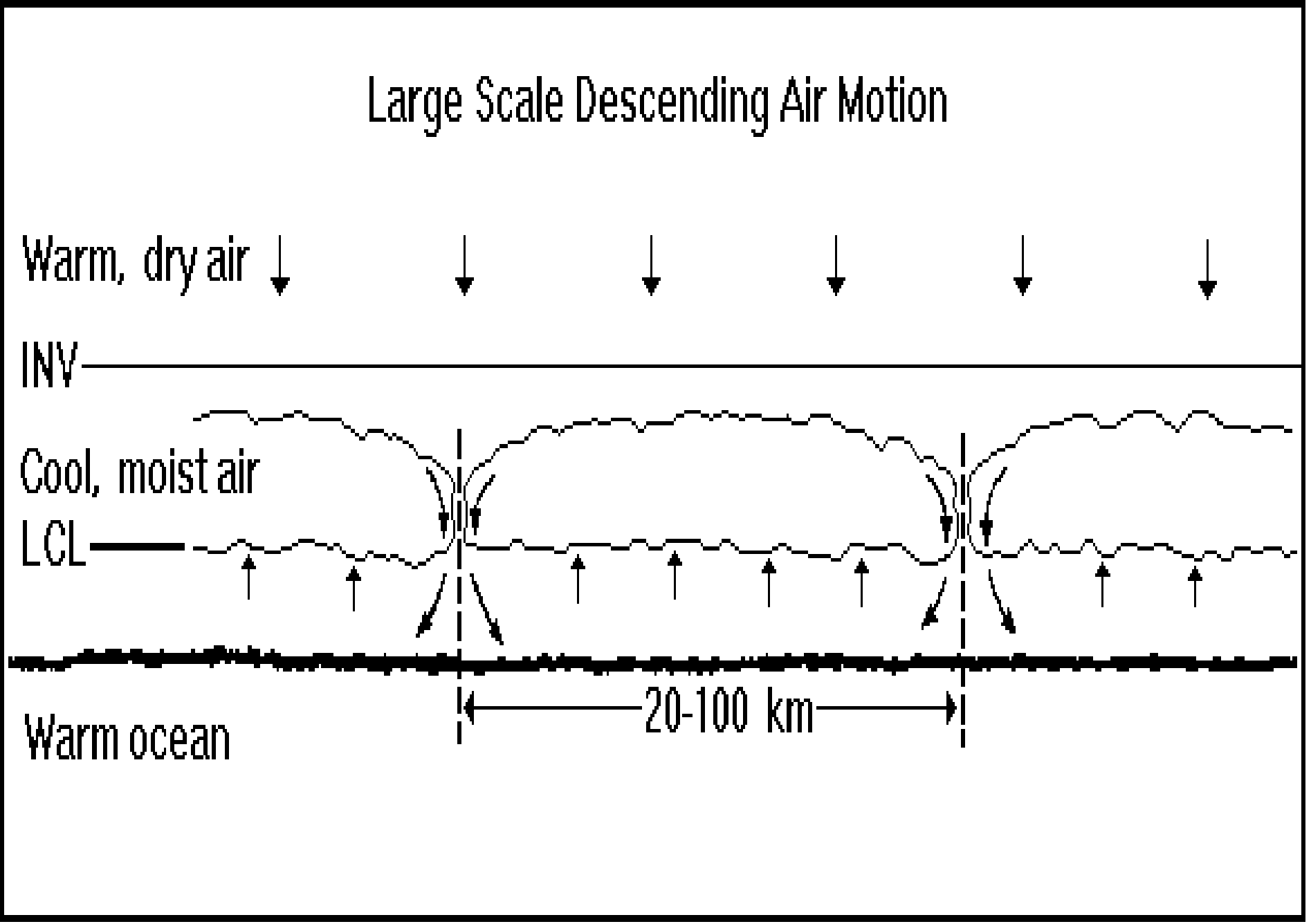


Cloud Identification

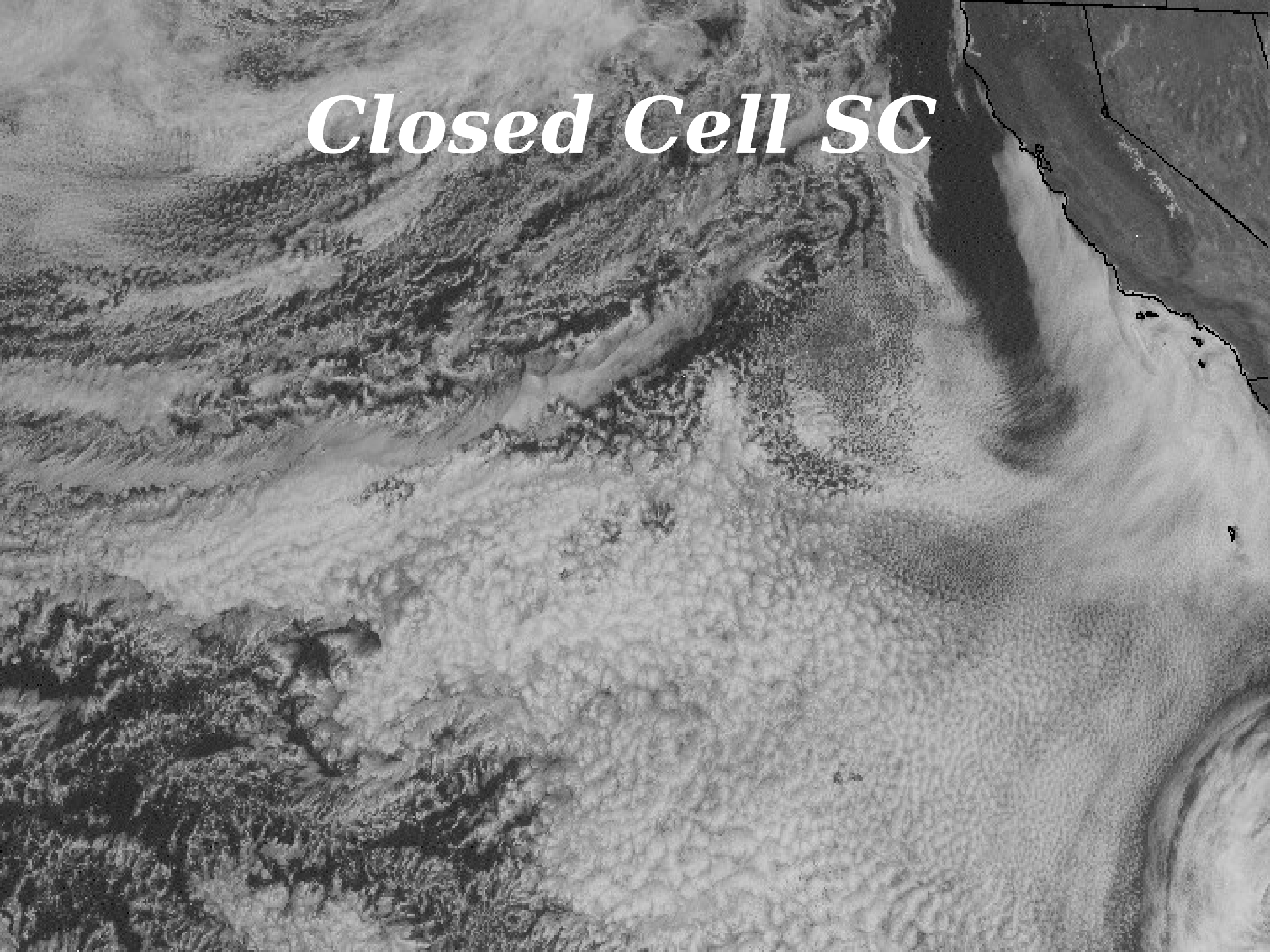
- Closed-Cell Stratocumulus - form where a shallow unstable layer exists below a stable layer aloft and are associated with anticyclonic flow ove r ocean regions

  .

  - Appearance on VIS - white in the center, medium gray to white on the edges and has quilt-like appearance; slight separation between elements.
  - Appearance on IR - medium to dark gray.



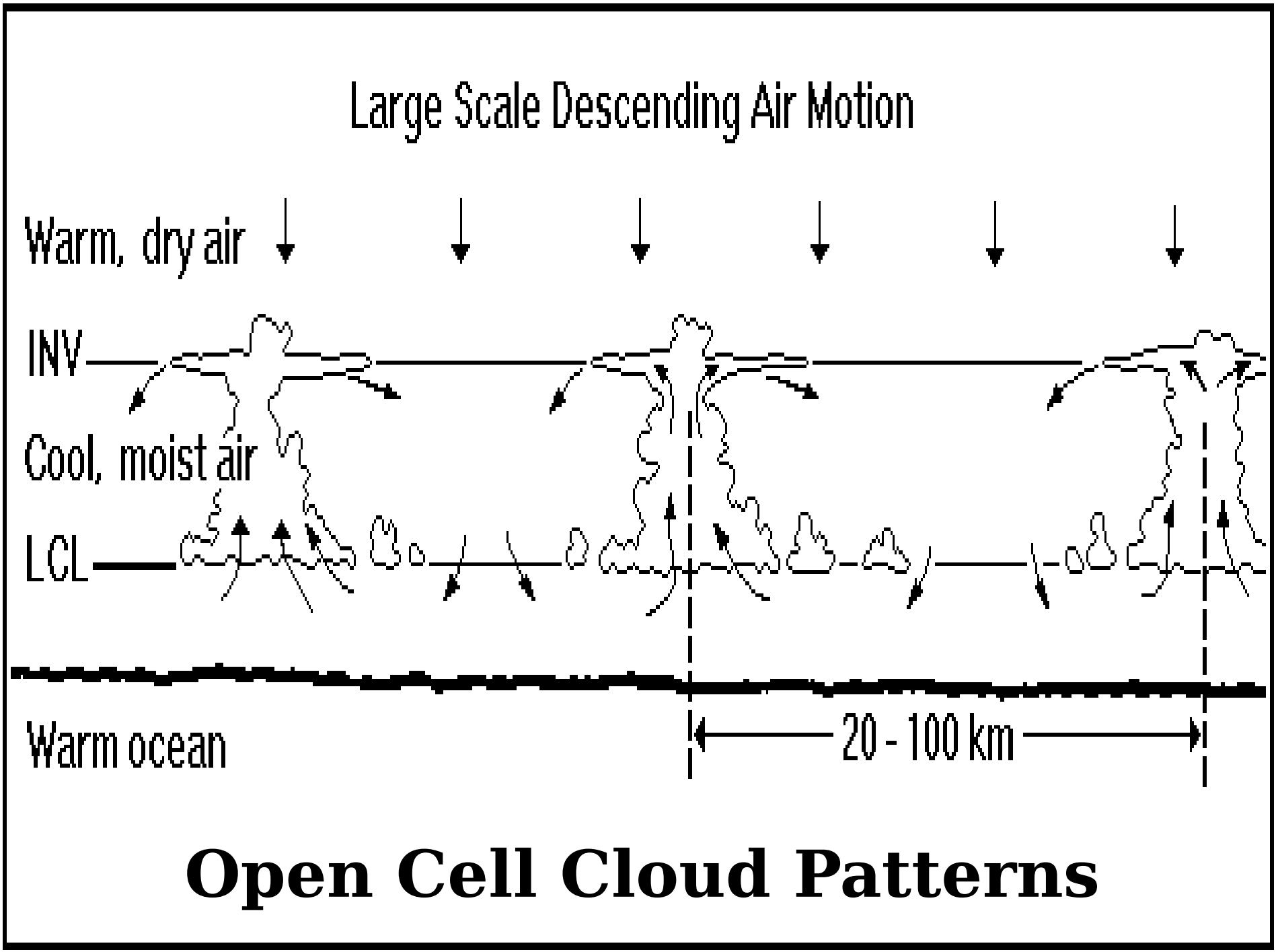
Closed Cell Cloud Patterns


Closed Cell SC

Closed Cell SC

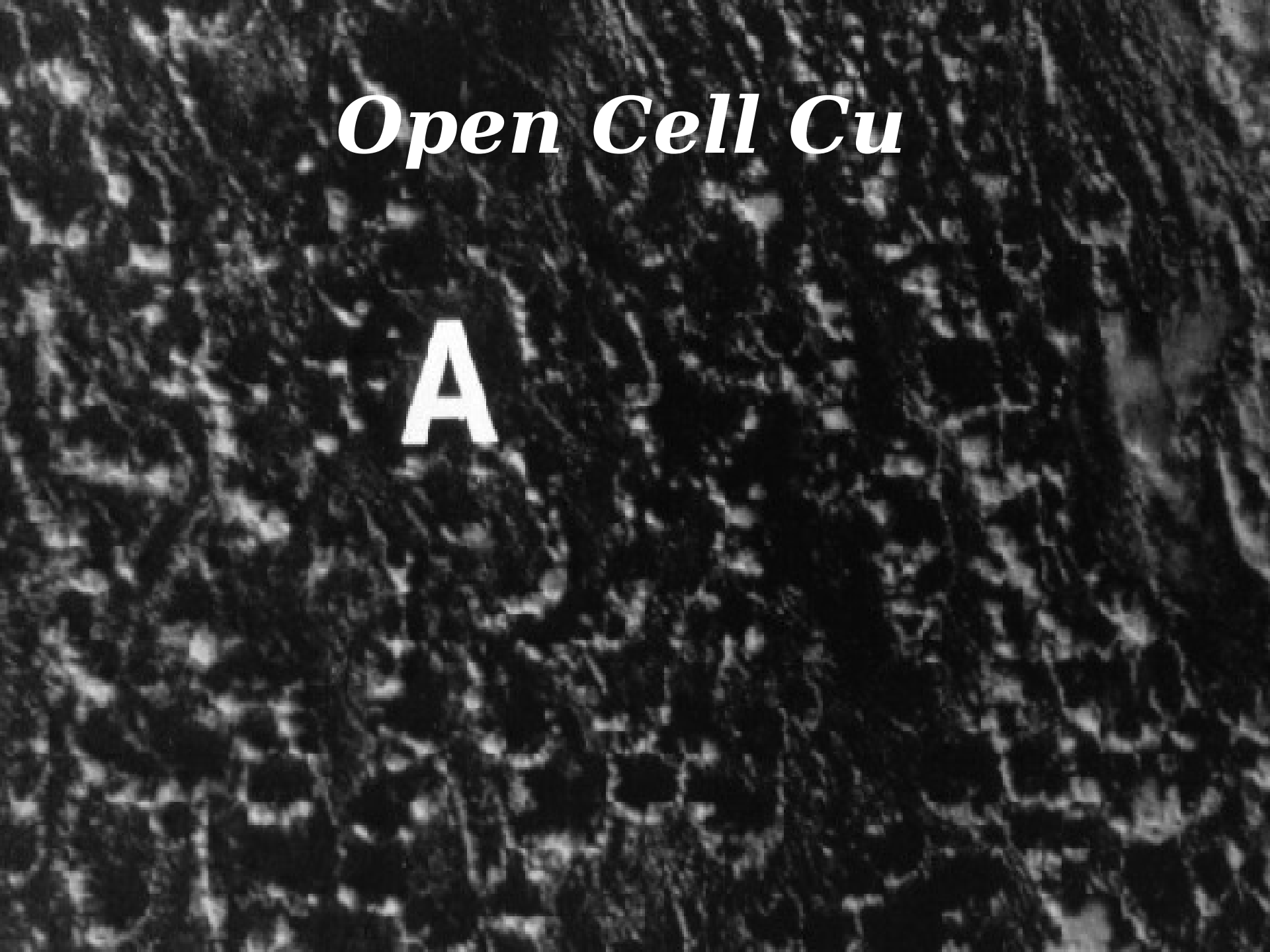
Cloud Identification

- Open-Cell Cumulus - form (generally) over water where atmosphere is unstable at low levels and aloft and are associated with straight line or cyclonic wind flow
  - Appearance on VIS - open and closed ringlets of cumulus with clear centers
  - Appearance on IR - medium to dark gray due to contamination and the sensor resolution



Open Cell Cloud Patterns

Open Cell
Cu


Open Cell Cu
A

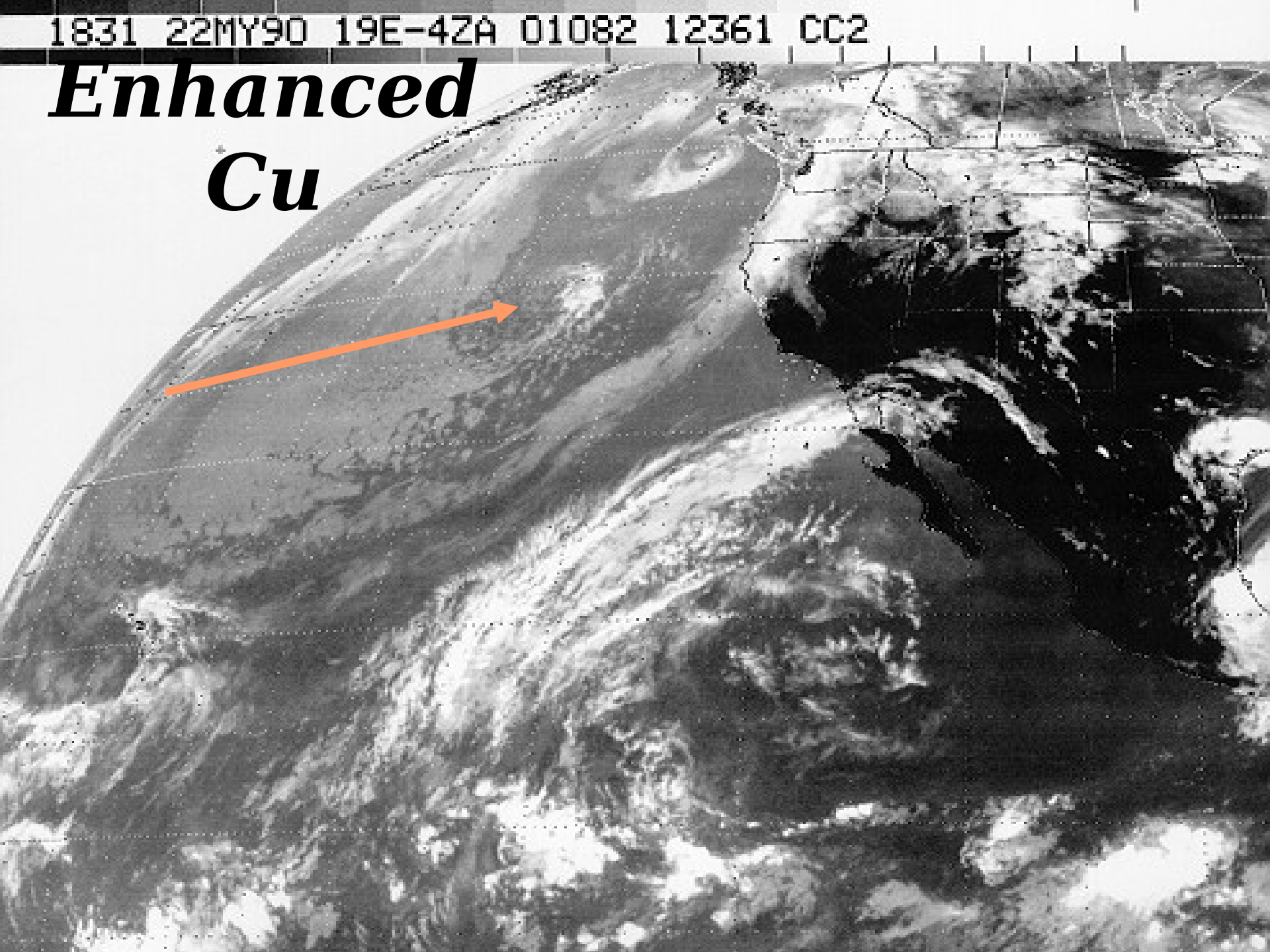
Open/Closed Cell

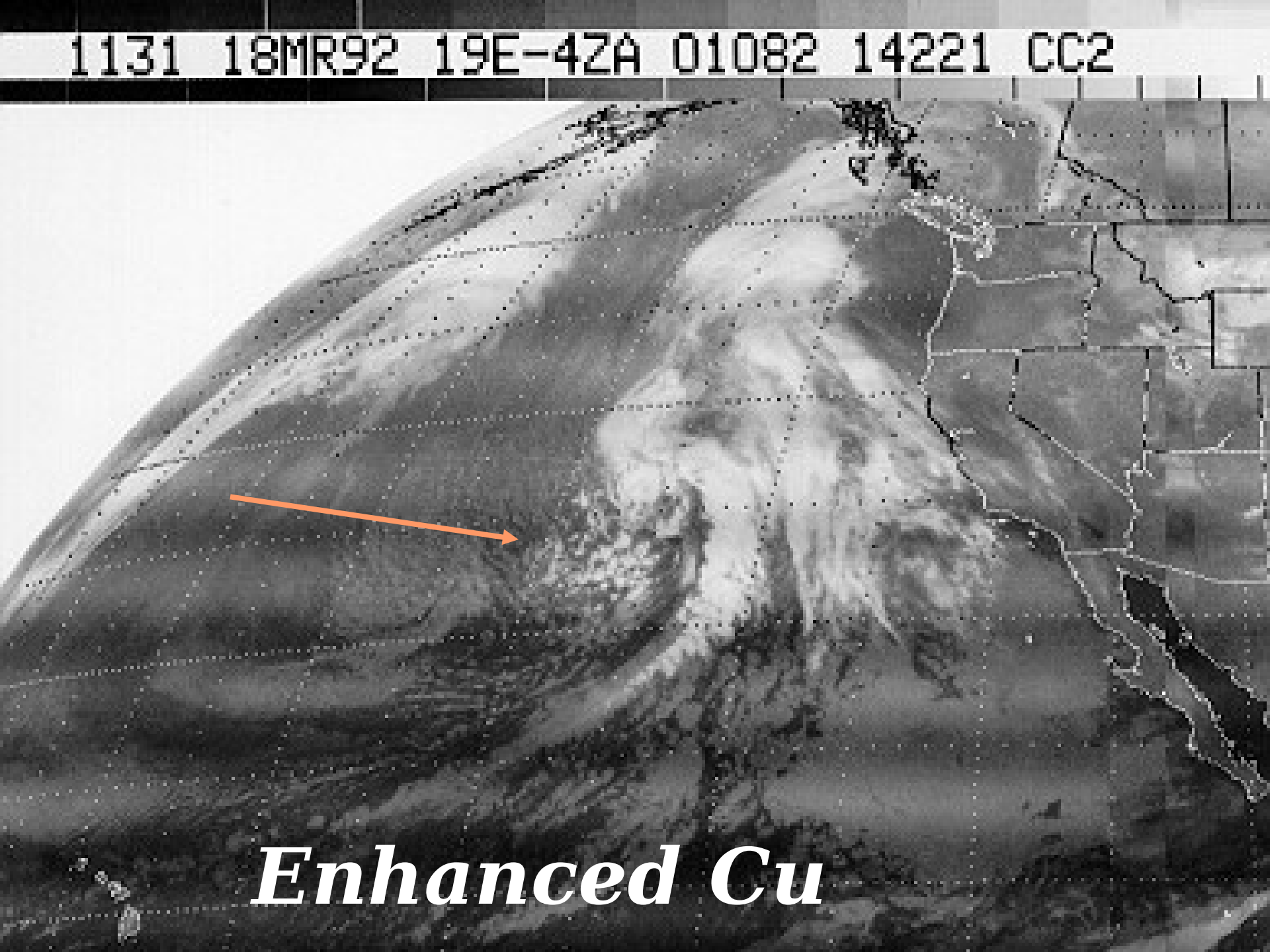
Cloud Identification

– Enhanced Cumulus - small patch of open-cell cumulus;
more vertically developed than remainder of open-cell cumulus field

.

- Appearance on VIS - similar to towering cumulus/small cumulonimbus clouds and the cloud mass often takes on a comma shape.
- Appearance on IR - similar to towering cumulus or small cumulonimbus and the comma shape is often easiest to detect in the cold cloud tops.


1831 22MY90 19E-4ZA 01082 12361 CC2
Enhanced
Cu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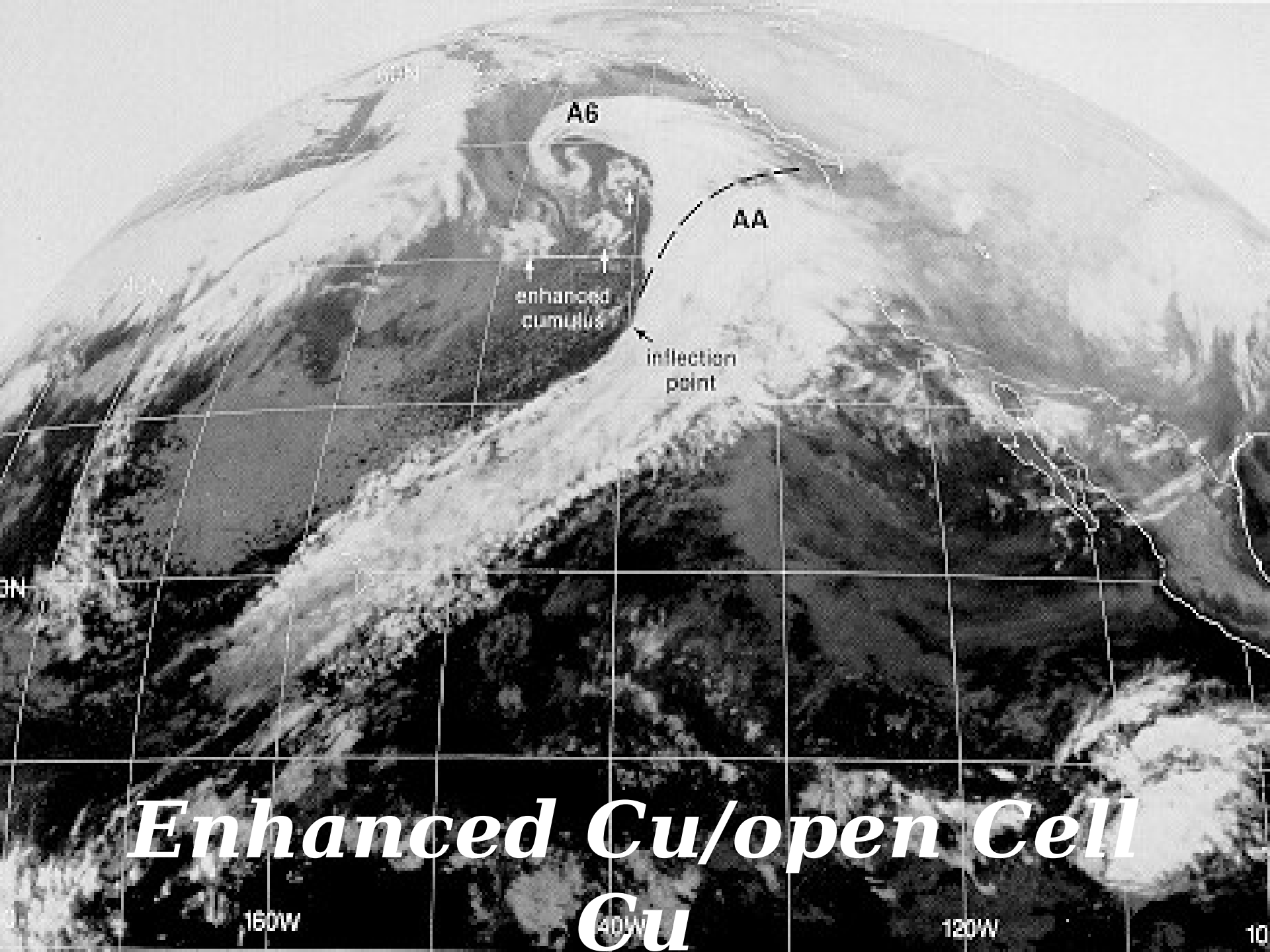
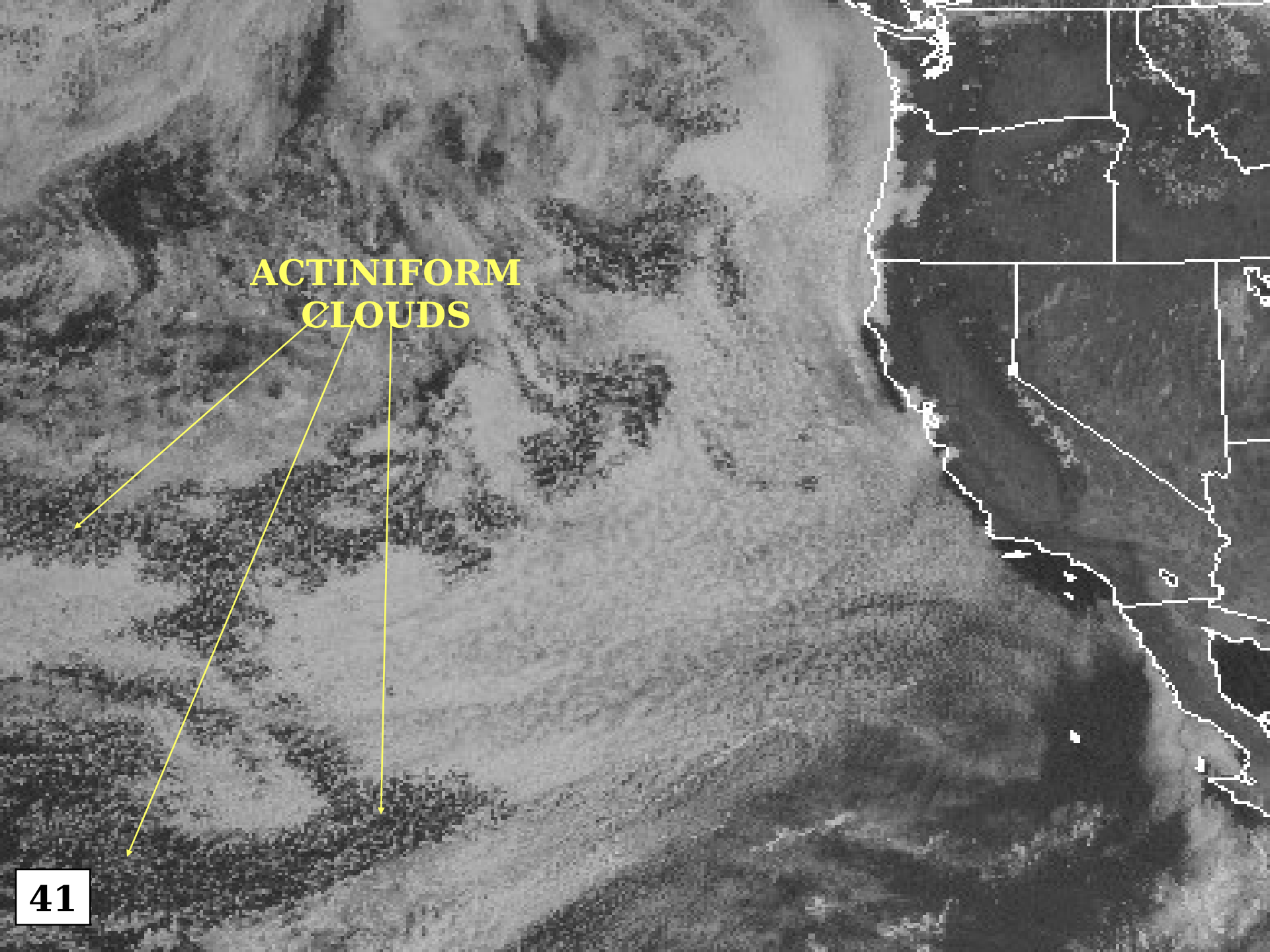
Enhanced Cu



Enhanced Cu/open Cell Cu

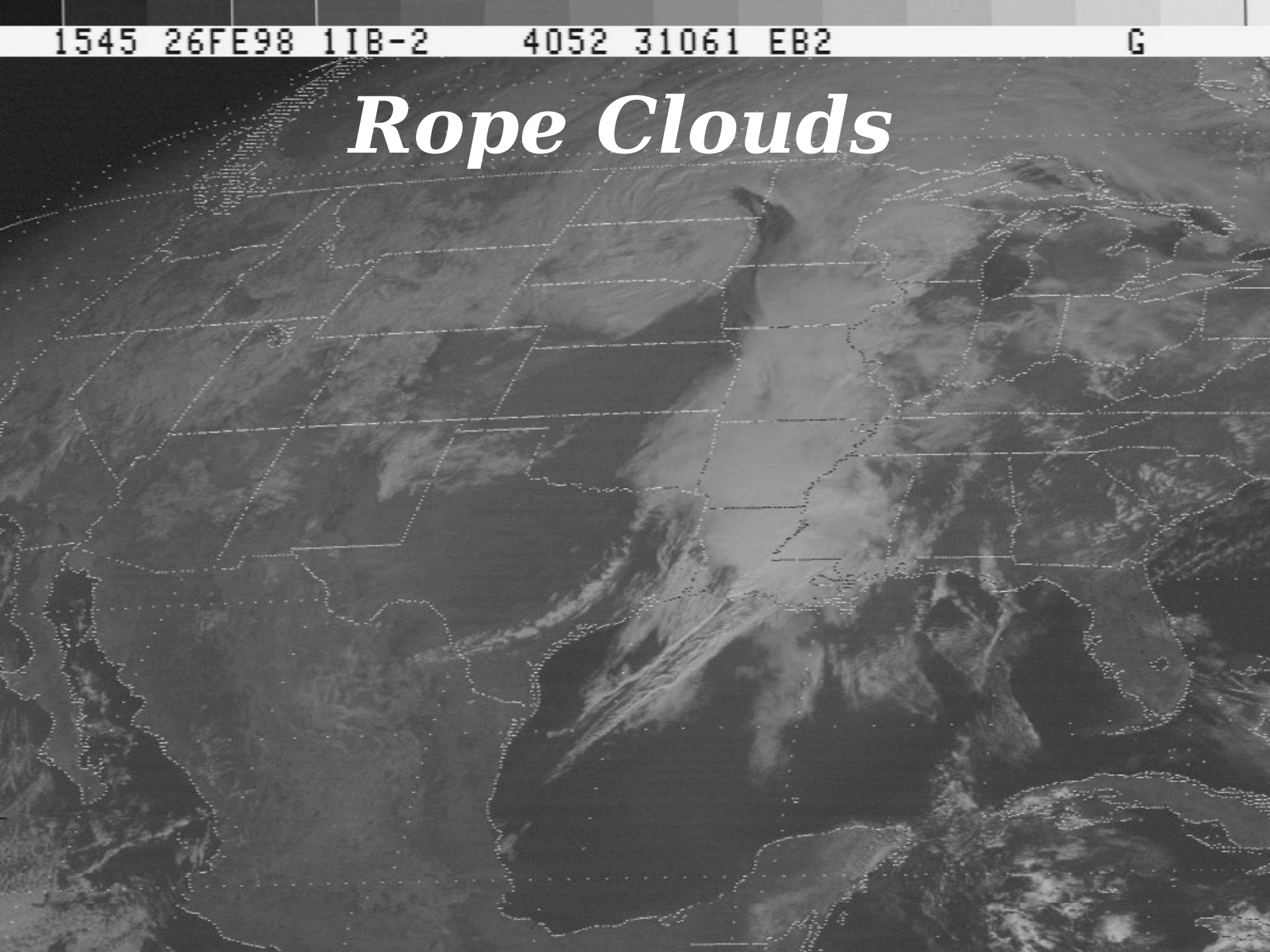
Cloud Identification

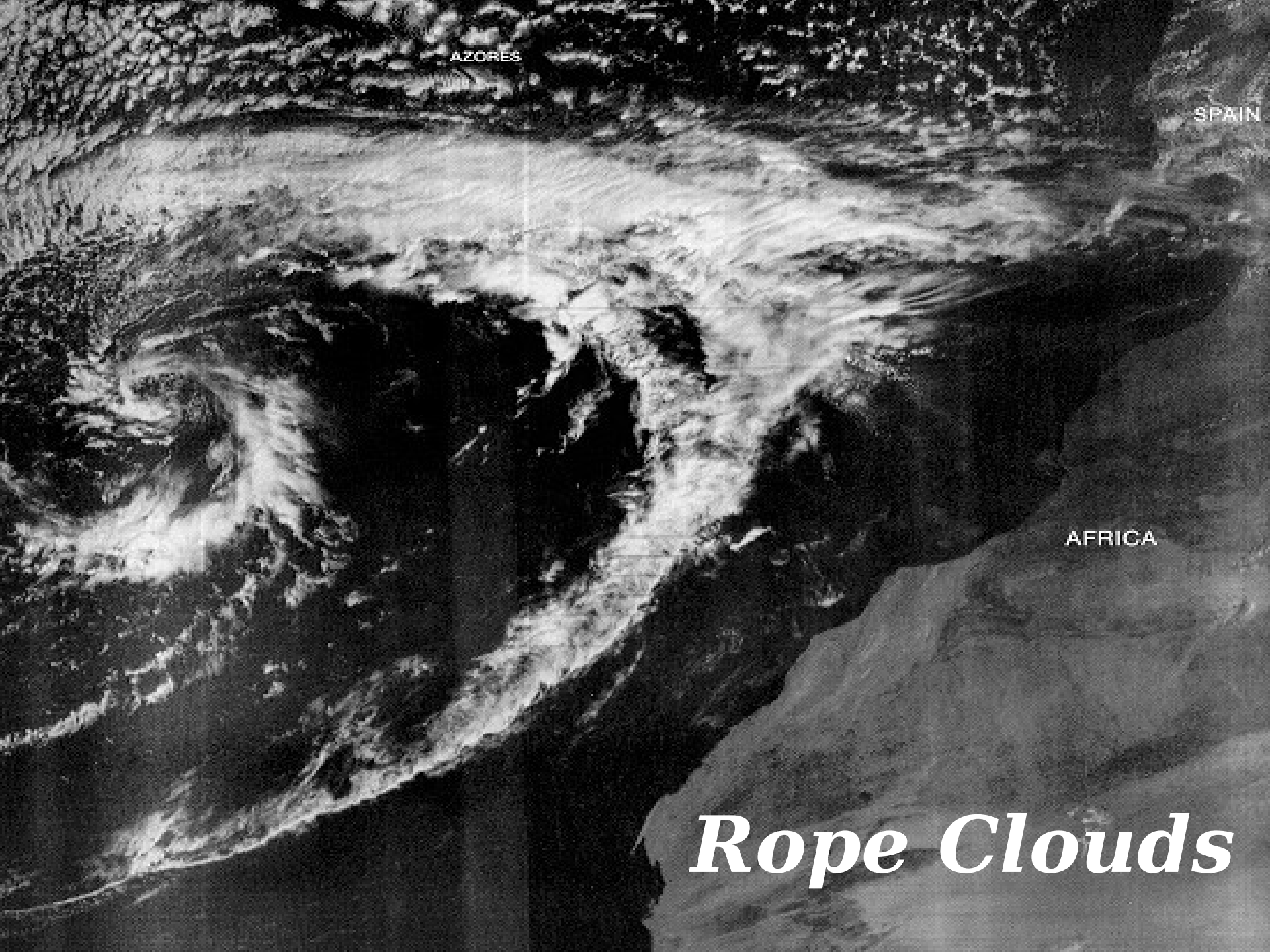
- Actiniform Clouds - the skeletal remains of closed-cell stratocumulus and appear similar to open-cell cumulus; found along western edge of the closed-cell stratocumulus field
  - Appearance on VIS - light gray due to contamination, often with a spider web appearance
  - Appearance on IR - medium gray to dark gray, but are slightly warmer than open-cell cumulus
    - Individual elements are not identifiable
    - If too much contamination occurs, the area will appear as a dark spot or hole in the stratocumulus field


ACTINIFORM
CLOUDS

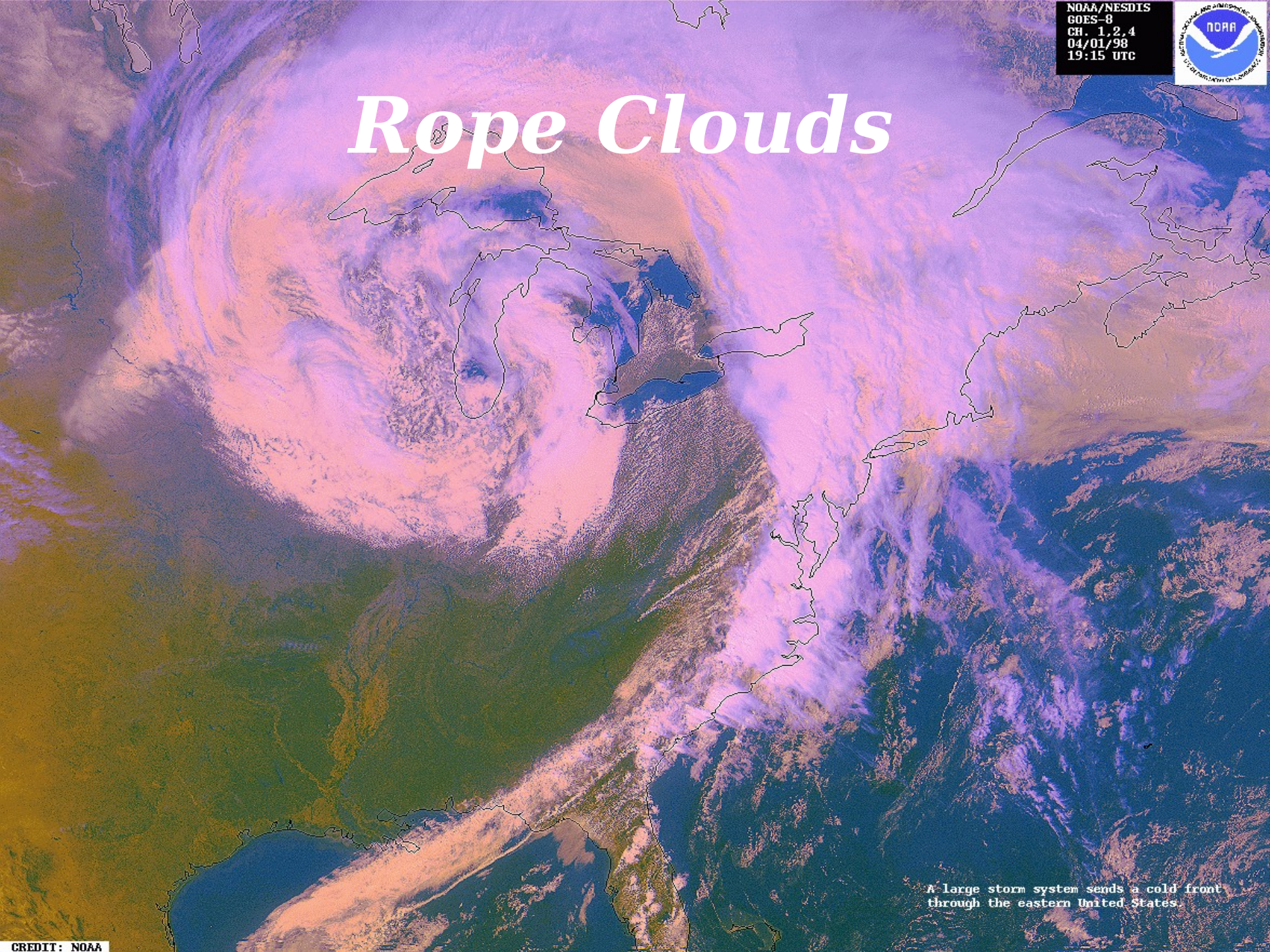
Cloud Identification

- Rope Cloud - thin cumulus or small towering cumulus organized into a line. Common over water.
  - Appearance on VIS - similar to cumulus or towering cumulus and are identified by observing the rope-like configuration.
  - Appearance on IR - the rope normally is less contaminated than ordinary cumulus; appears slightly lighter.

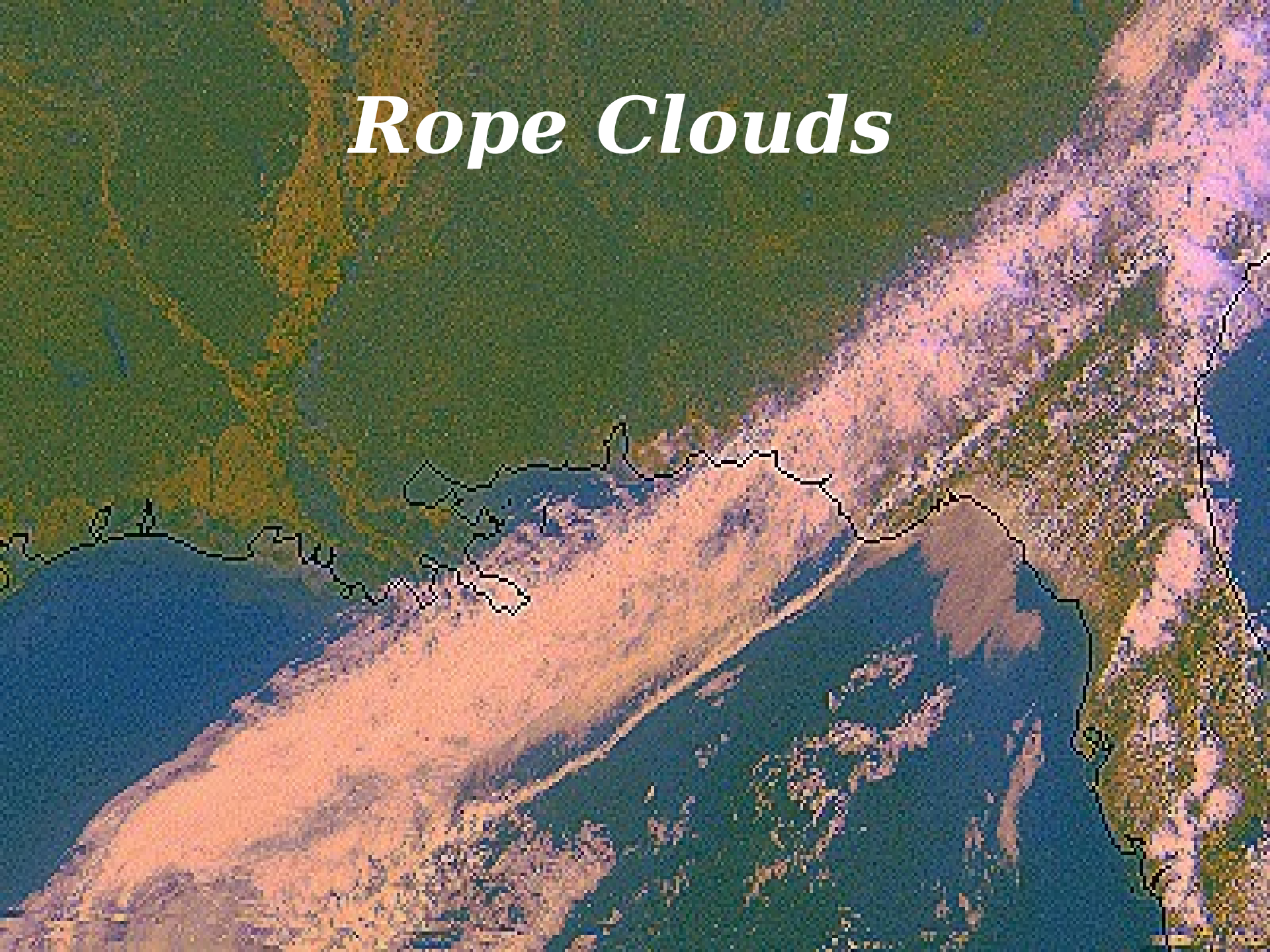

1545 26FE98 1IB-2 4052 31061 EB2 G
Rope Clouds



Rope Clouds


NOAA/NESDIS
GOES-8
CH. 1,2,4
04/01/98
19:15 UTC
NOAA
Rope Clouds
A large storm system sends a cold front through the eastern United States.
CREDIT: NOAA

Rope Clouds

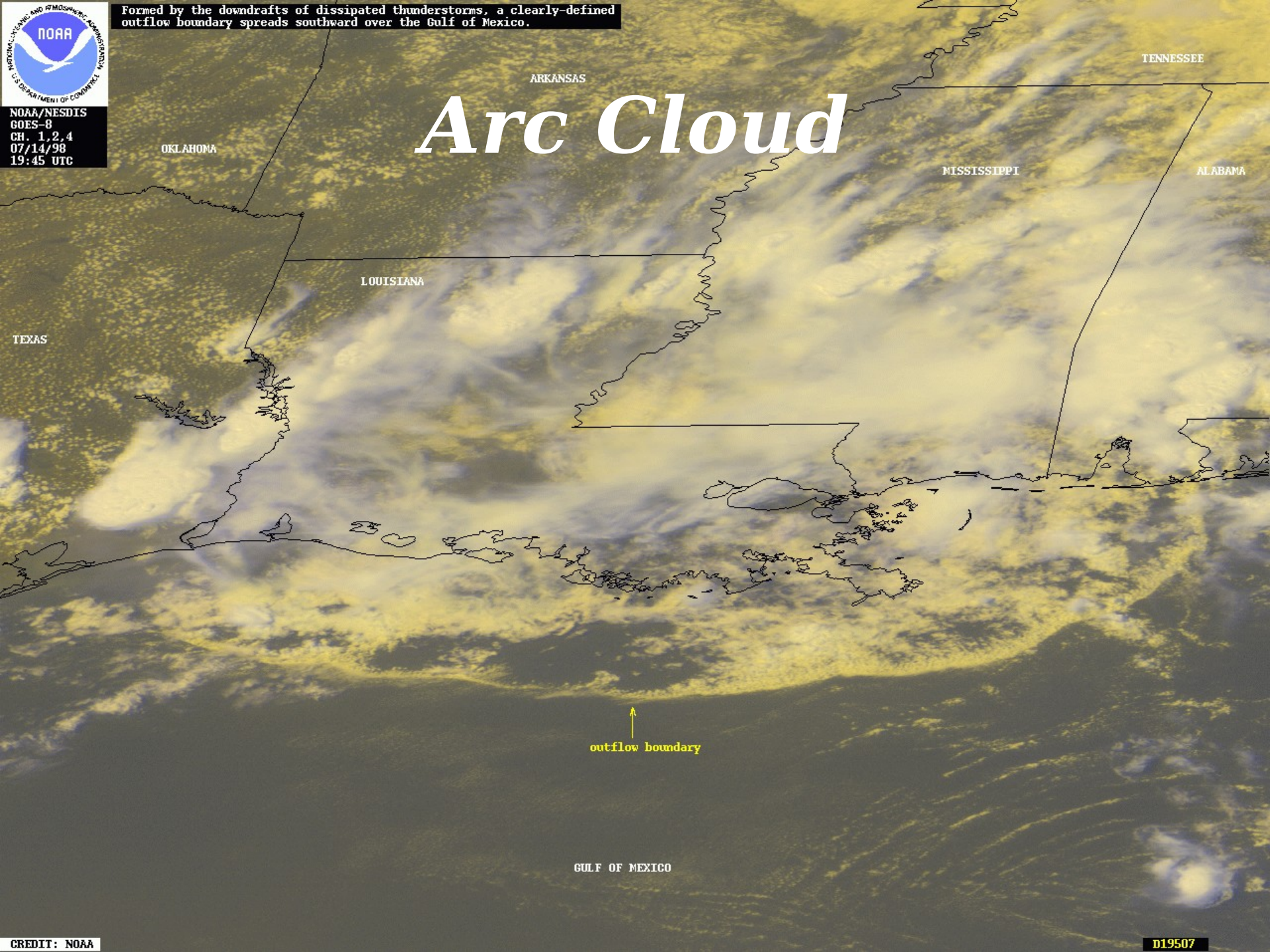


Cloud Identification

- Thunderstorm Outflow Boundaries (Arc Clouds) -
  line of cumulus or towering cumulus w hich is slightly curved
  - Appearance on VIS - similar to a rope cloud except that the parent thunderstorm is normally still apparent on the convex side of the boundary
  - Appearance on IR - similar to a rope cloud

Arc Cloud

Arc Cloud

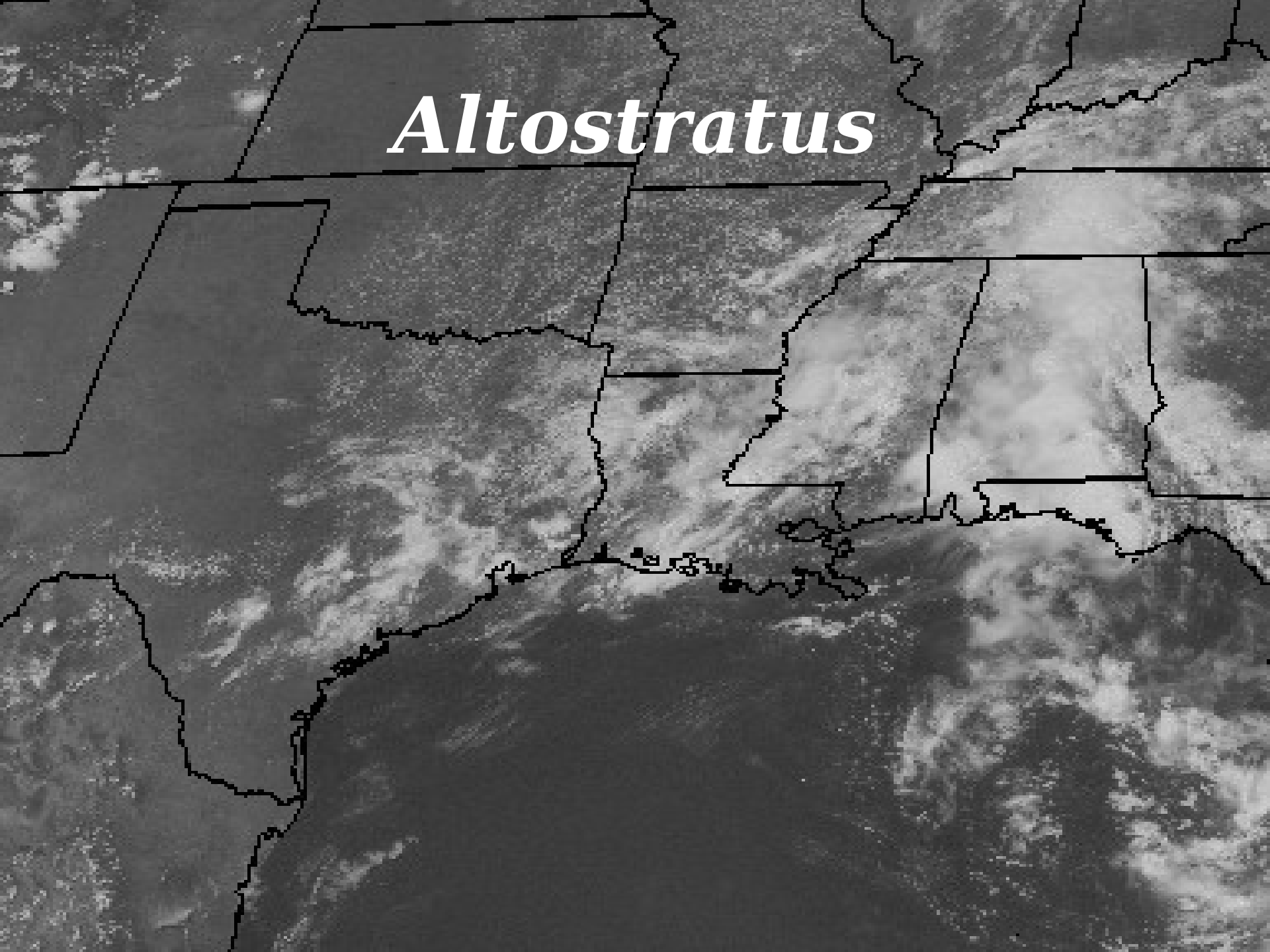

Formed by the downdrafts of dissipated thunderstorms, a clearly-defined outflow boundary spreads southward over the Gulf of Mexico.
NOAA/NESDIS
GOES-8
CH. 1,2,4
07/14/98
19:45 UTC
Arc Cloud
ARKANSAS
TENNESSEE
OKLAHOMA
MISSISSIPPI
ALABAMA
LOUISIANA
TEXAS
outflow boundary
GULF OF MEXICO
CREDIT: NOAA
D19507

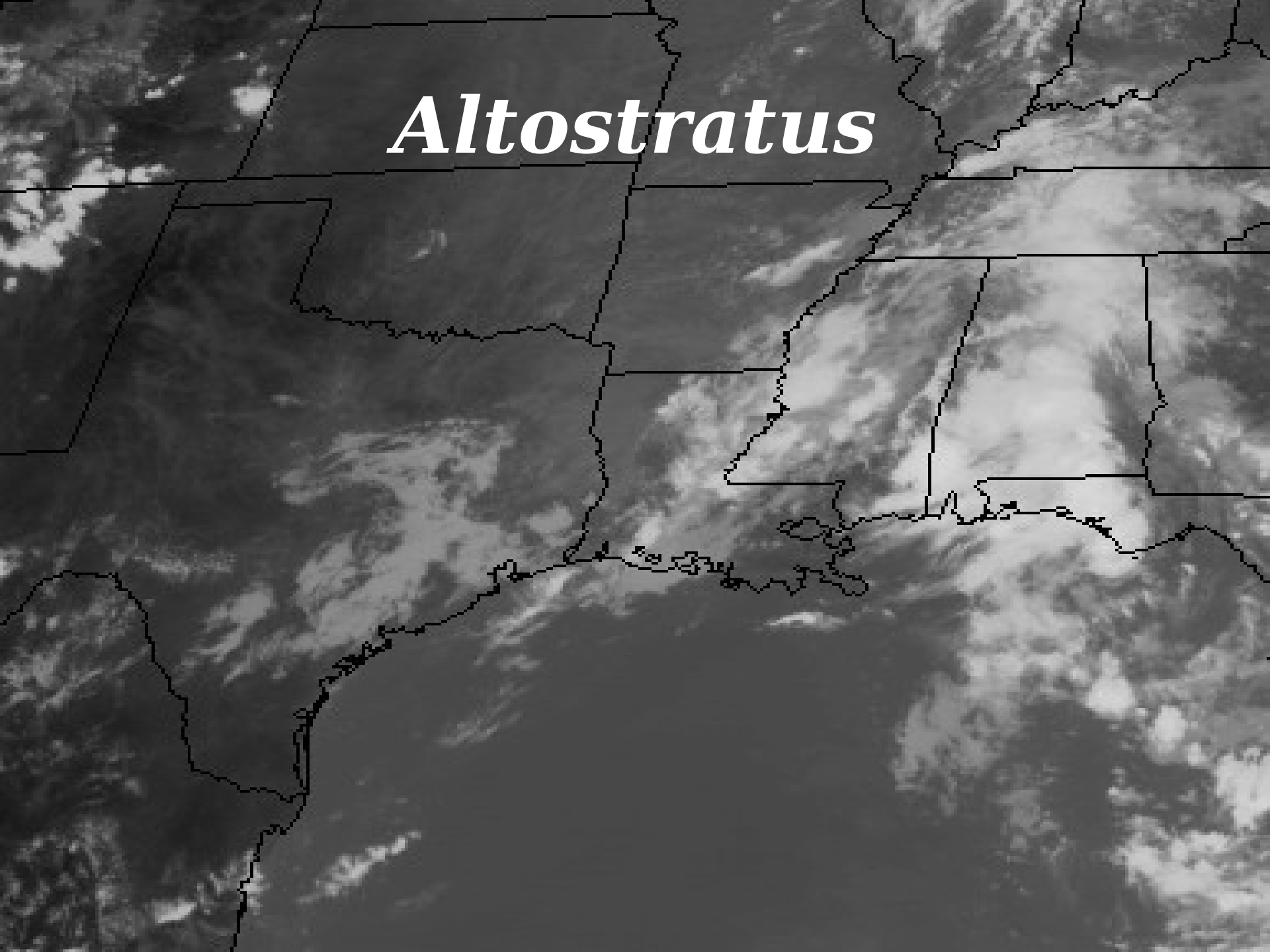
GOES Project
(NASA-GSFC
GOES-9
Rapid-scan test
8 am - 8 pm EDT
July 2, 1995
South Florida
July 13th edition
1995 Jul 2 12:11 UTC

Cloud Identification

- Middle Clouds
  - Altostratus/Nimbostratus - found in eastern portions of cyclones and on leading edge of frontal systems and are often masked by cirrus/cirrostratus
    - Appearance on VIS - bright white and fairly uniform and normally cover extensive areas
    - Appearance on IR - uniform gray shade ranging from medium gray to light gray and depending on the enhancement curve used, they may appear as an enhanced region

Middle Clouds


Altostratus

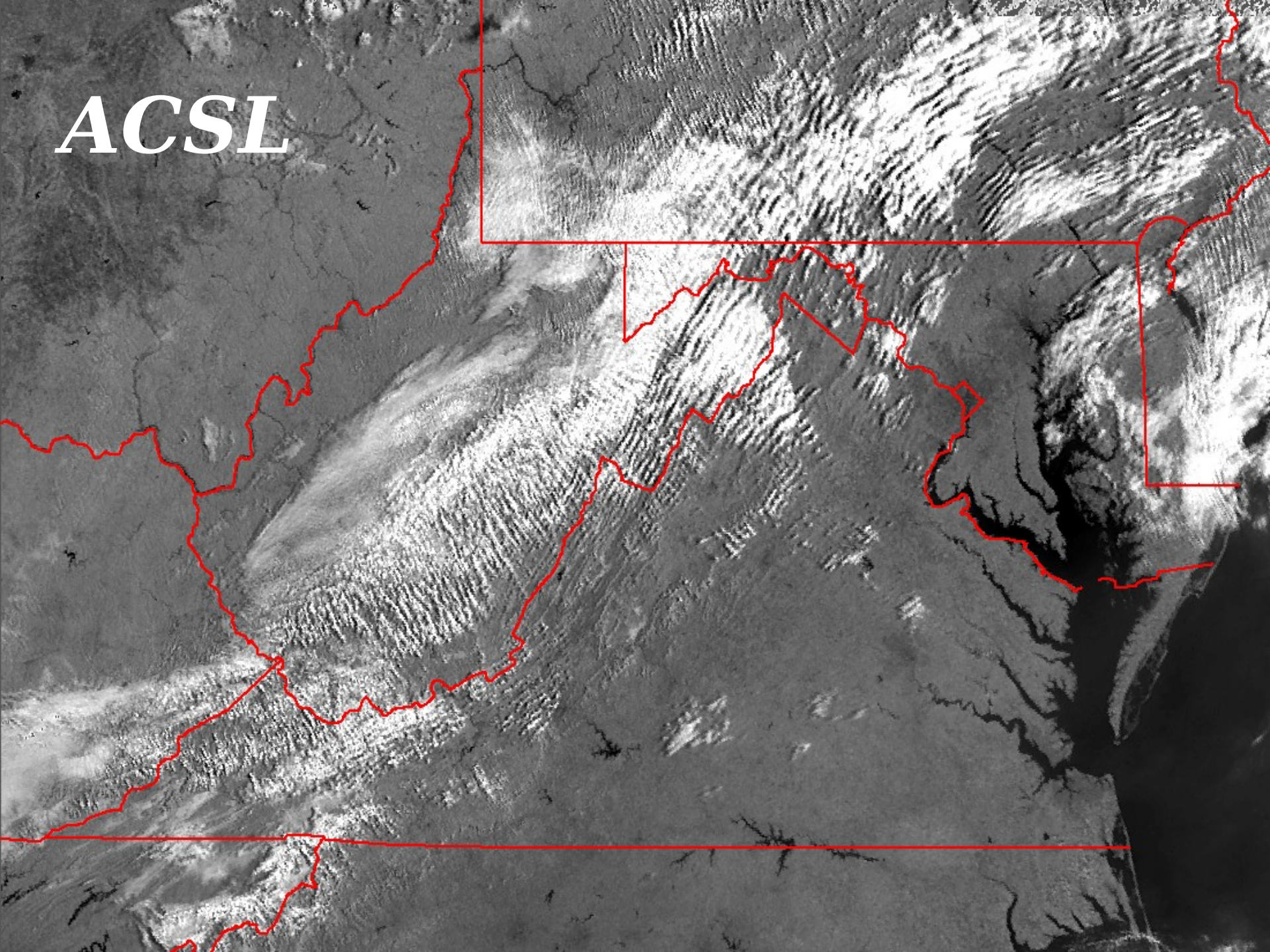

Altostratus

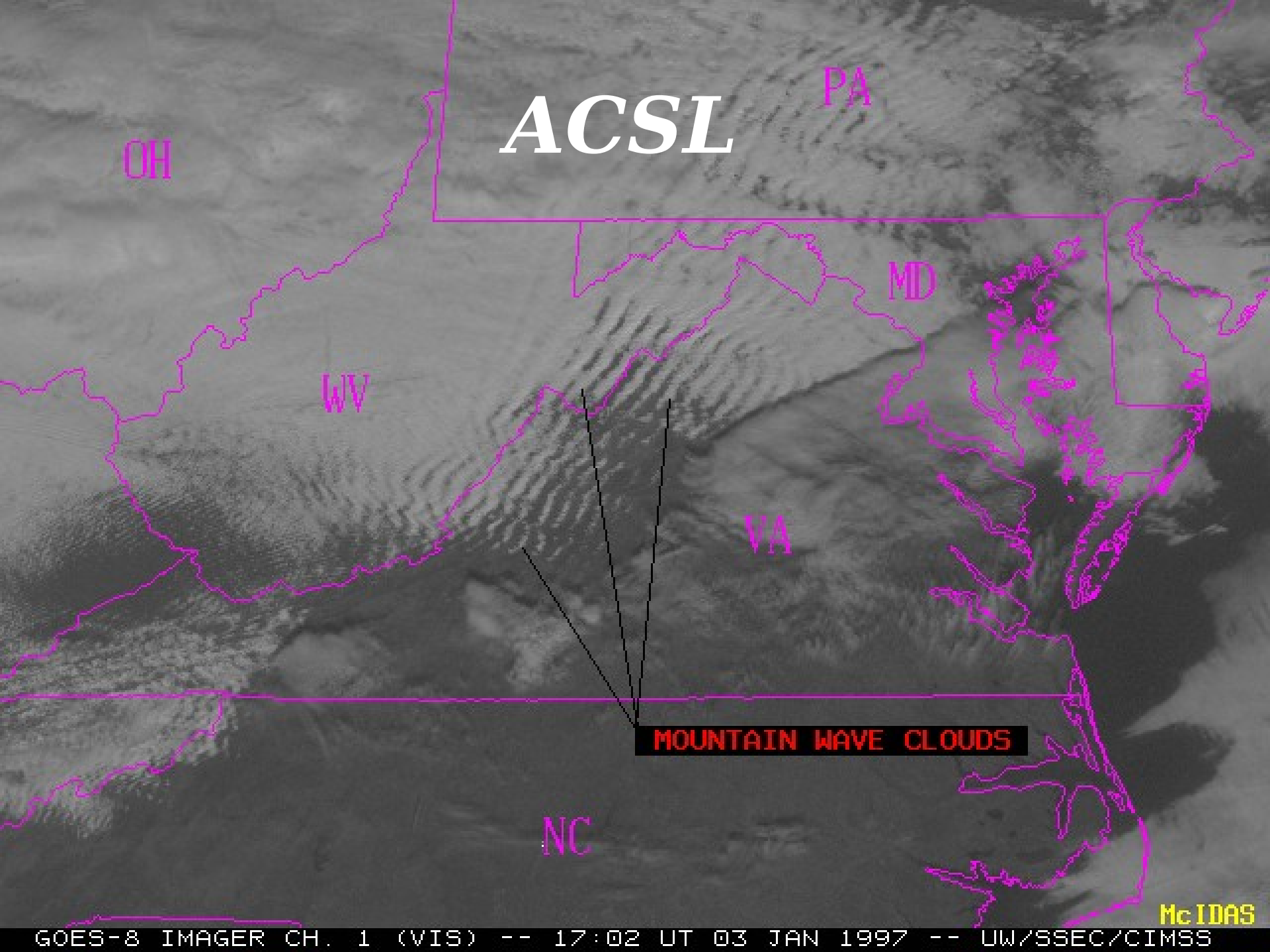
Cloud Identification

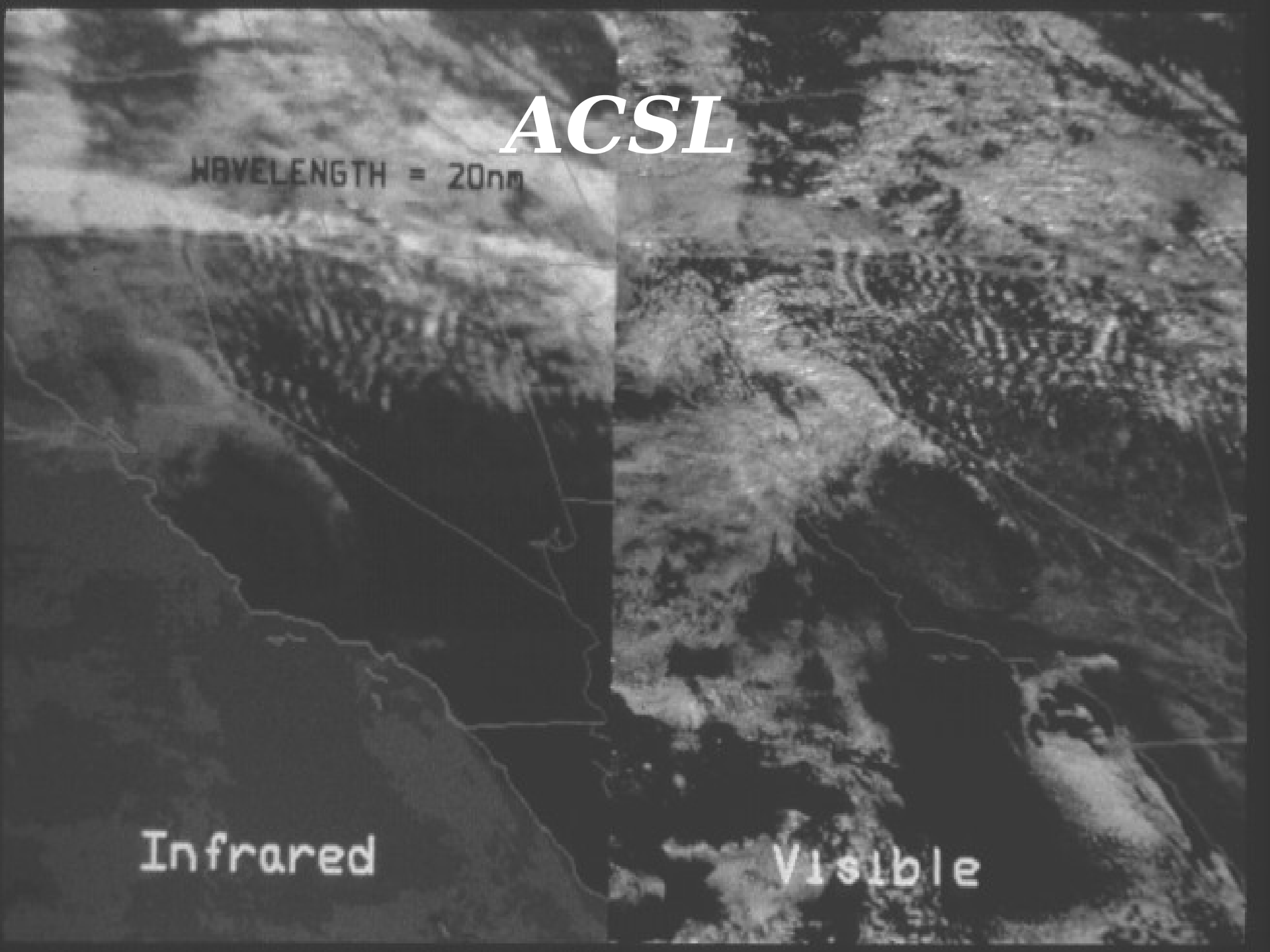
- Altocumulus
  - Appearance on VIS - bright white cloud sheet; textured or lumpy appearance
  - Appearance on IR - similar to altostratus or nimbostratus

Cloud Identification

- Altocumulus Standing Lenticular (ACS L)
  - also known as mountain wave clouds, they form when strong mid-level winds flow nearly perpendicular to a mountain range
    - Appearance on VIS - light gray to white; washboard (banded) appearance
    - Appearance on IR - range from medium gray to white and individual elements often too small to be detected by IR sensor


ACSL

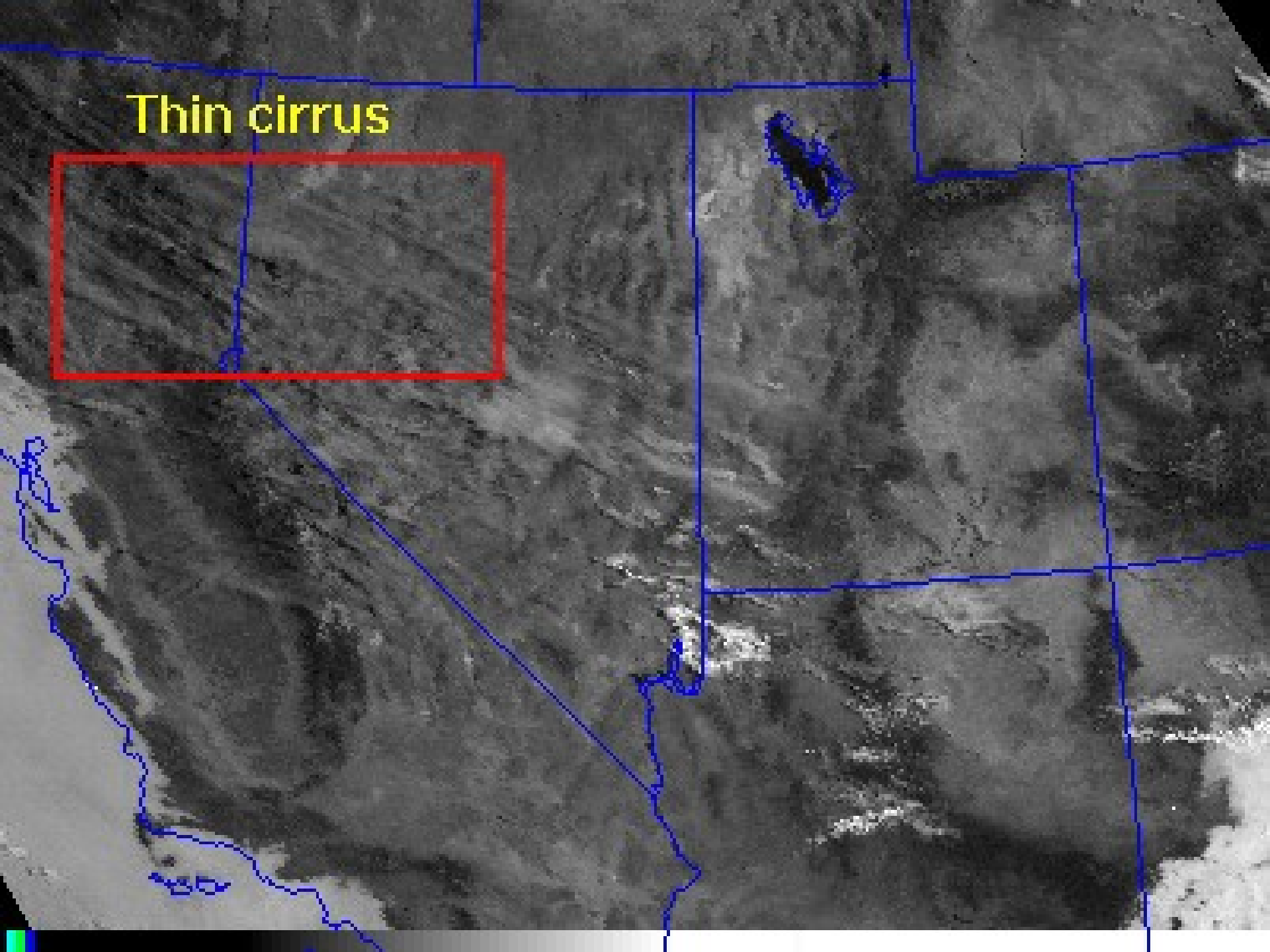

ACSL
PA
OH
MD
WV
VA
MOUNTAIN WAVE CLOUDS
NC
McIDAS
GOES-8 IMAGER CH. 1 (VIS) -- 17:02 UT 03 JAN 1997 -- UW/SSEC/CIMSS


ACSL
WAVELENGTH = 20nm
Infrared
Visible

High Clouds

Cloud Identification

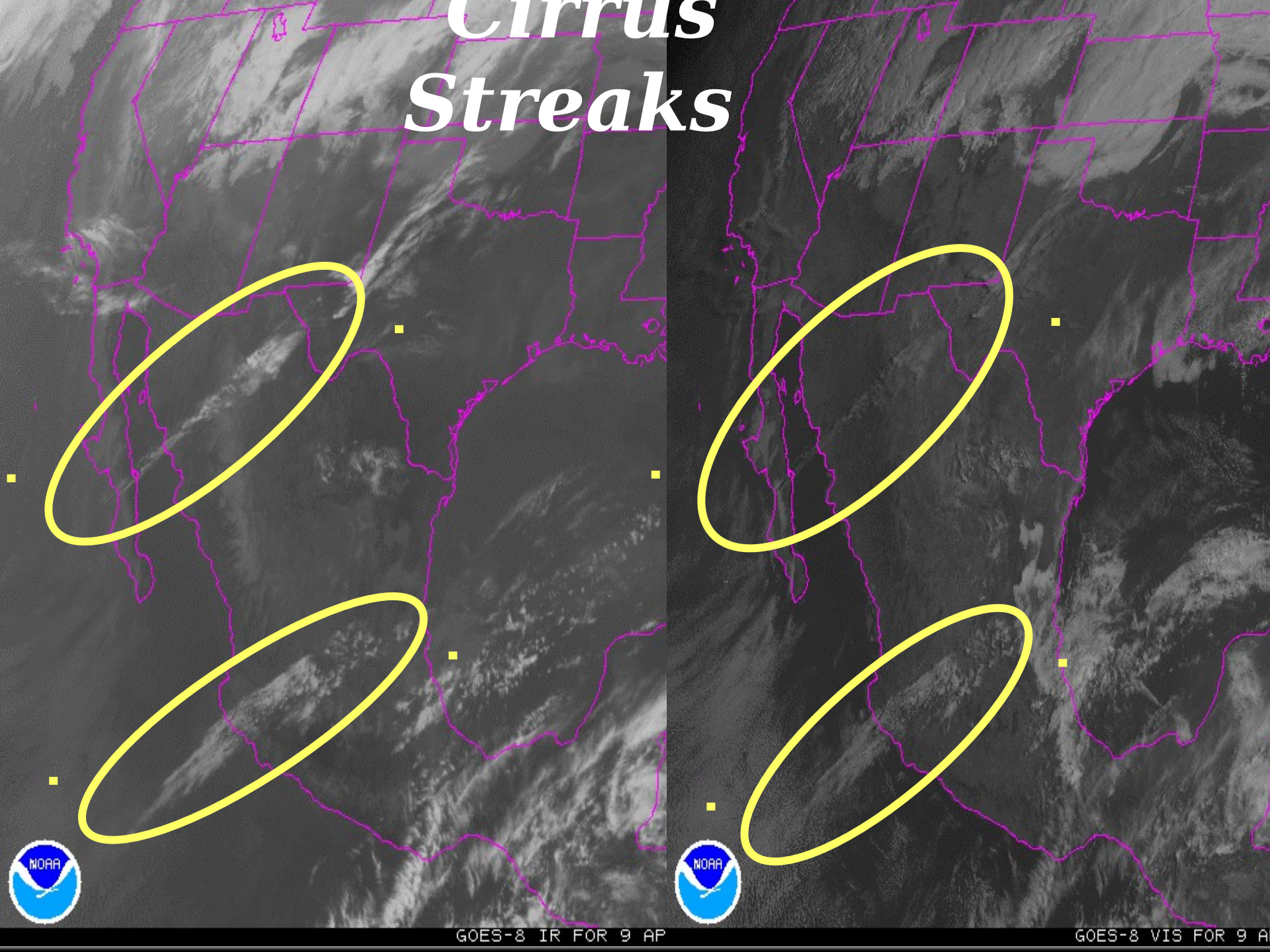
- High Clouds
  - Cirrus
    - Appearance on VIS
      - Thin cirrus difficult to detect because of contamination
      - Dense cirrus looks like patches, streaks, or bands, and casts shadows on lower clouds or terrain features
    - Appearance on IR - thin cirrus is normally contaminated, but is cold enough to be discernible over the warm background while dense cirrus appears cold
    - Appearance on WV - ranges from light gray to bright white depending on cloud thickness


Thin cirrus

Cloud Identification

- Special types of cirrus clouds
  - Cirrus streaks
    - These are small isolated patches of cirrus generally occurring away from other clouds
    - These are elongated by upper-level wind flow and develop in areas with insufficient moisture for entire cirrus shield to form
    - Appearance on VIS - thin wisps of cirrus, highly contaminated

Cirrus Streaks



Cloud Identification

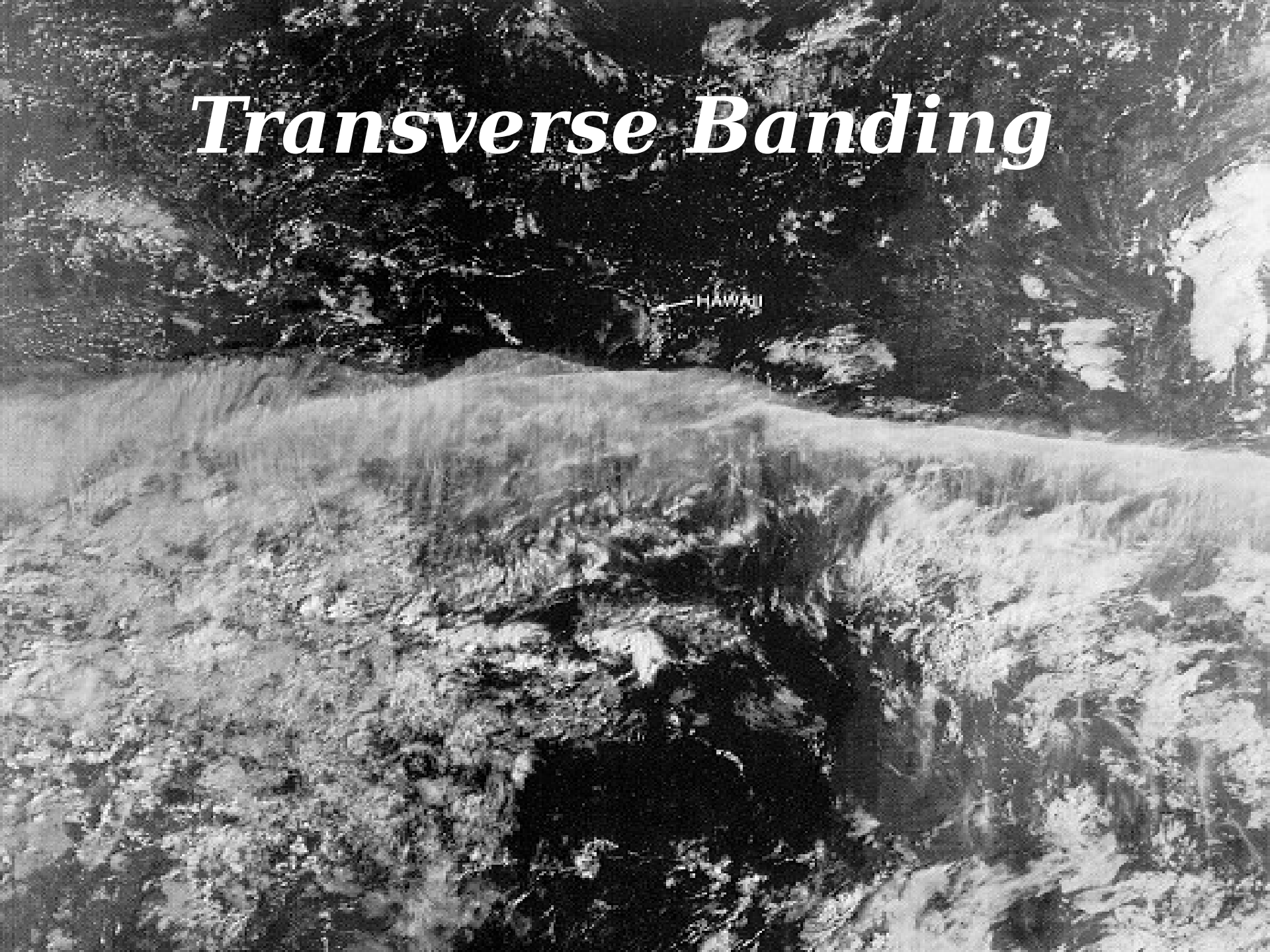
- Appearance on IR - medium gray to white
- Appearance on WV - light gray to white, depending on amount of moisture in the atmosphere

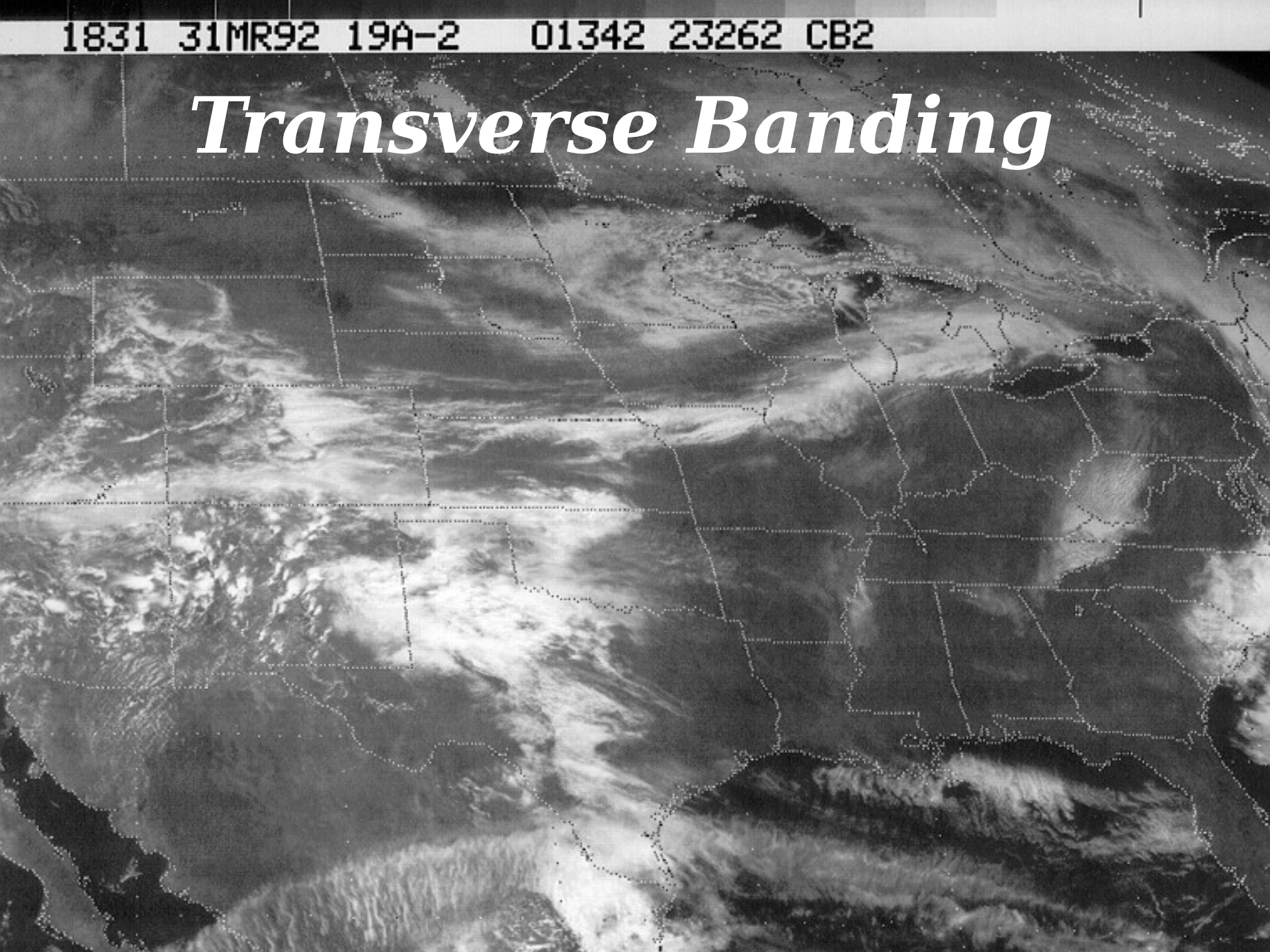
Cloud Identification

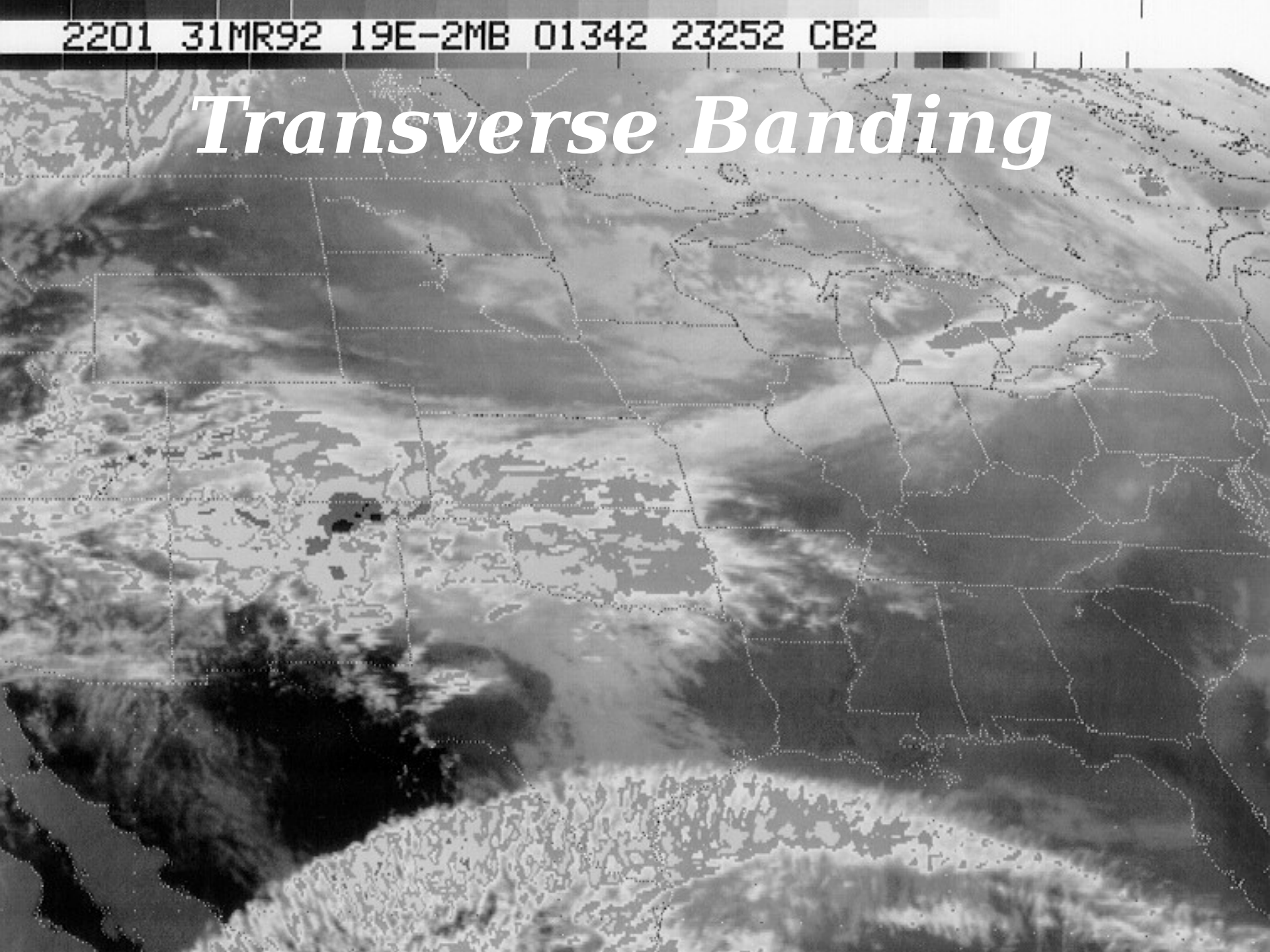
- Transverse Bands - irregularly spaced parallel bands of thin cirrus filaments and strands perpendicular to the wind flow
  - Caused by strong vertical wind shear near the jet stream
  - They appear similar to cirrus streaks on satellite imagery, but are oriented perpendicular to the flow

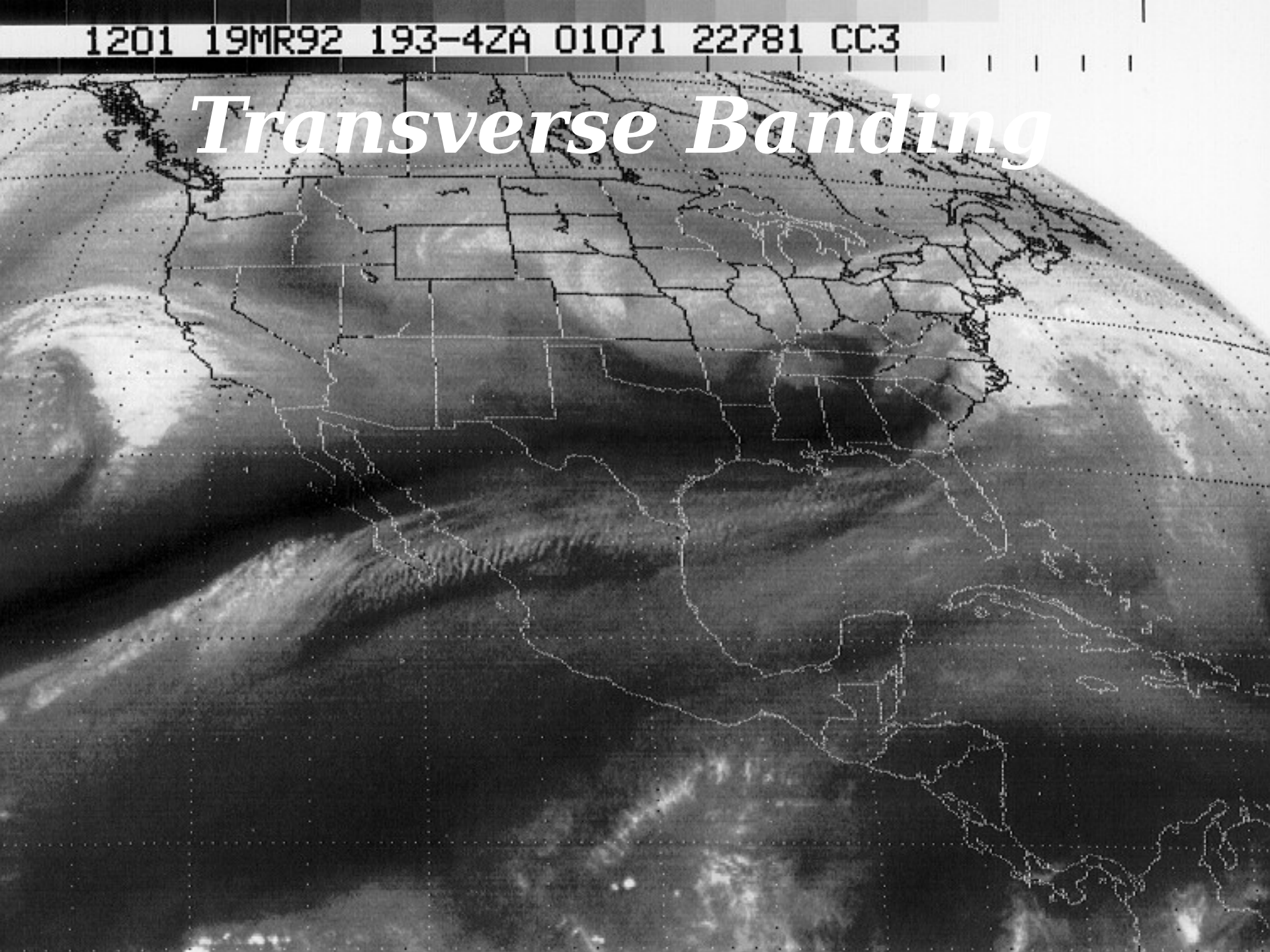
Transverse Banding

Transverse Banding




1831 31MR92 19A-2 01342 23262 CB2
Transverse Banding


2201 31MR92 19E-2MB 01342 23252 CB2
Transverse Banding

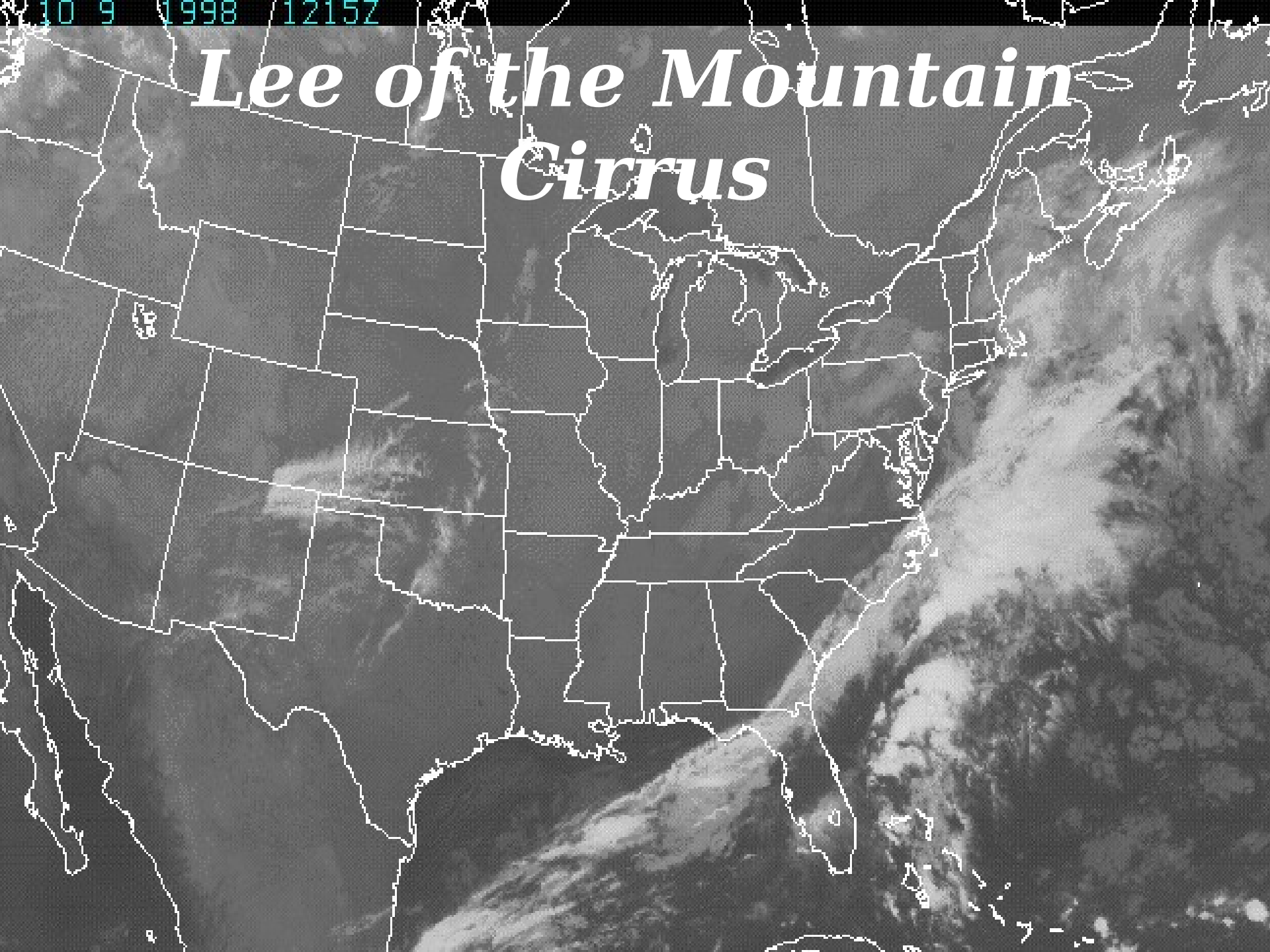

1201 19MR92 193-4ZA 01071 22781 CC3
Transverse Banding

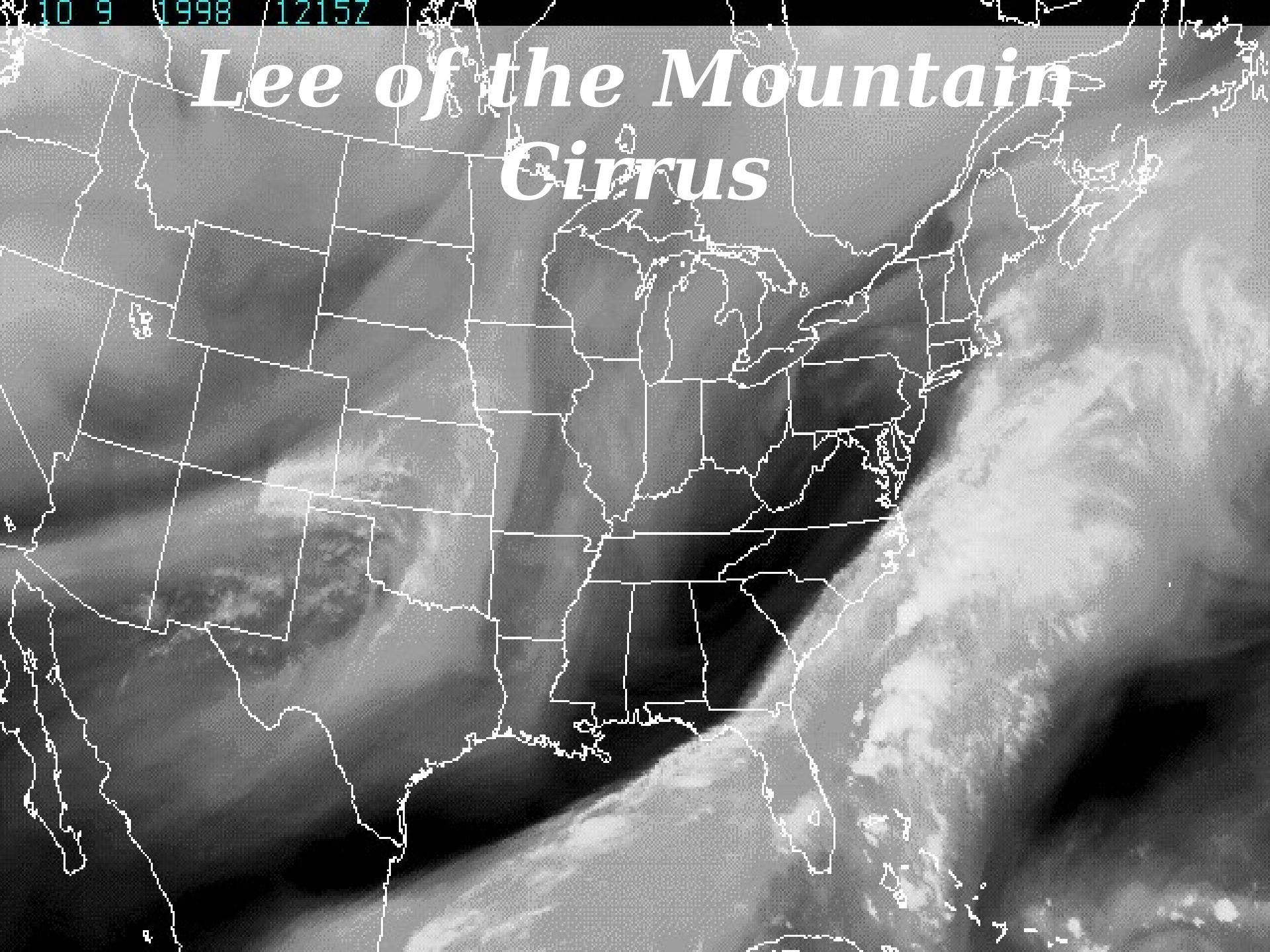
Cloud Identification

- Lee-of-the-Mountain Cirrus
  - Appearance on VIS
    - It is bright white with sharp edge along the mountain ridge line, becoming more diffuse downstream
    - Contamination is significant along the thin downstream edge
    - It can appear as thick as cirrostratus
  - Appearance on IR - bright white gray shade and dense regions normally appear enhanced

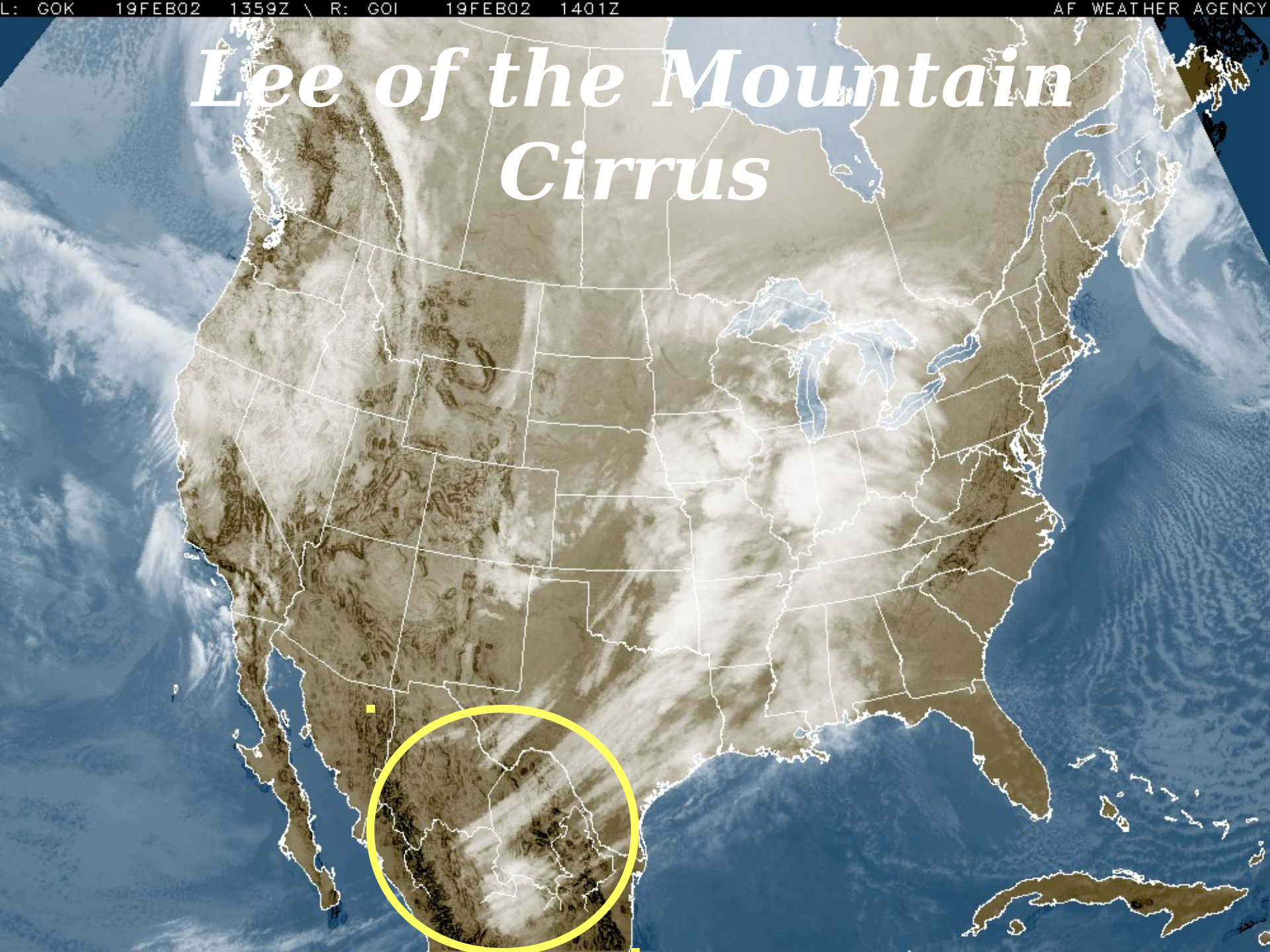
Cloud Identification

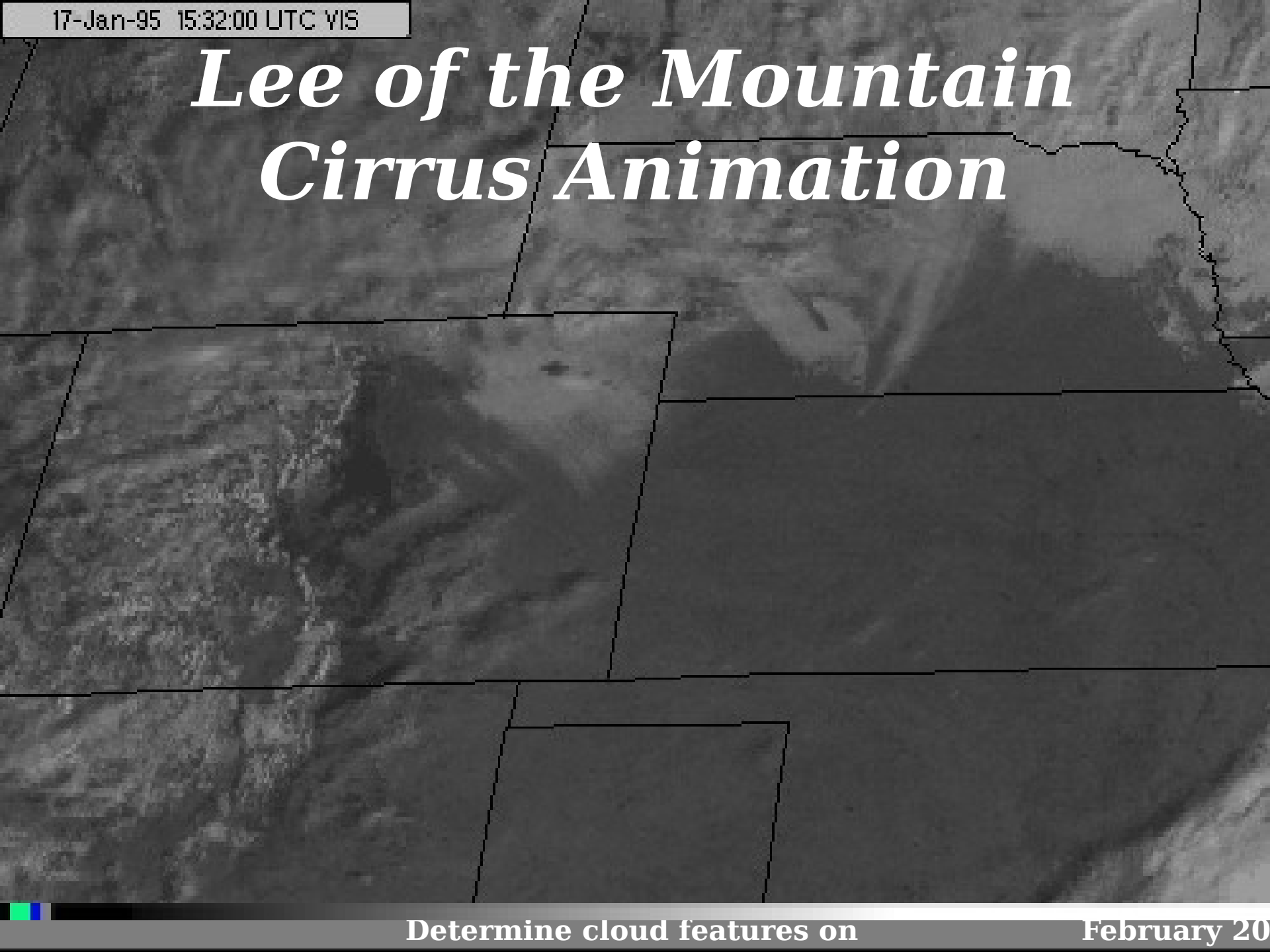
- Appearance on WV
  - It is bright white extending downstream from mountains
  - A dark band is normally located north of the cirrus; extends both upstream and downstream from the mountains


10 9 1998 /1215Z
Lee of the Mountain Cirrus


10 9 1998 1215Z
Lee of the Mountain Cirrus

Lee of the Mountain
Cirrus

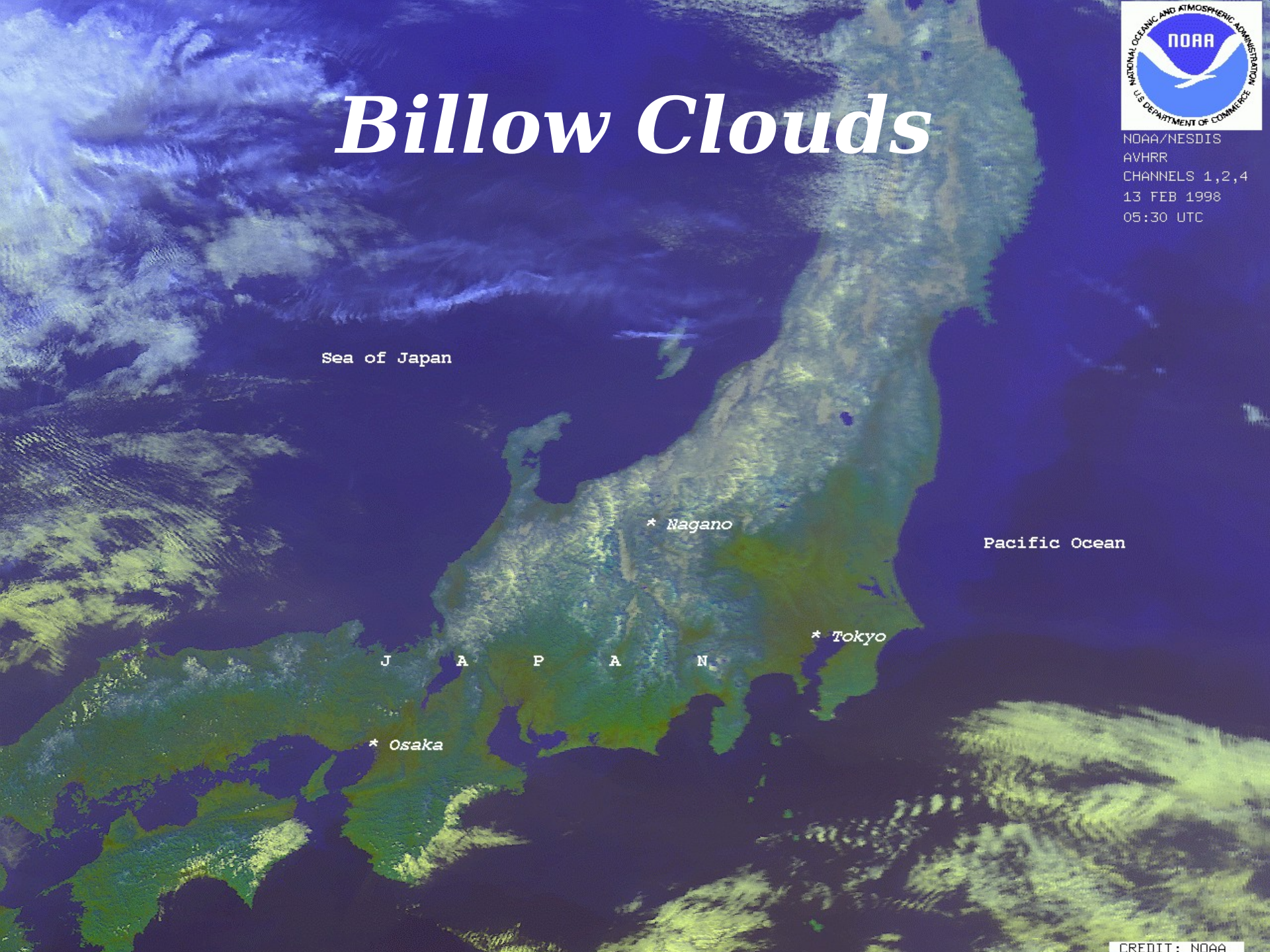

L: GOK 19FEB02 1359Z \ R: GOI 19FEB02 1401Z
AF WEATHER AGENCY
Lee of the Mountain Cirrus


17-Jan-95 15:32:00 UTC VIS
Lee of the Mountain
Cirrus Animation
Determine cloud features on
February 20

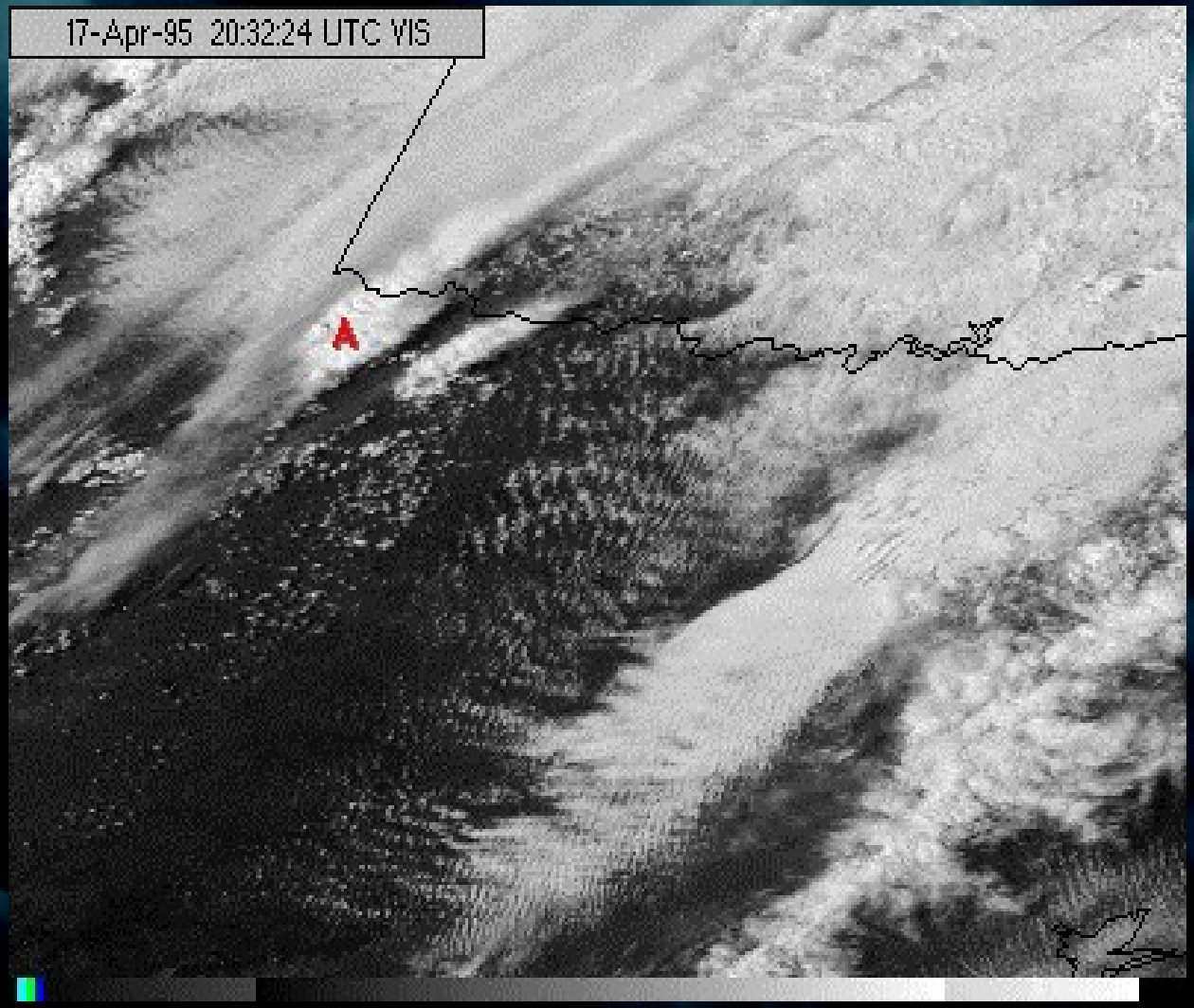
Cloud Identification

- Billow Clouds - regularly spaced clouds caused by strong vertical wind shear
  - Appearance on VIS - light gray to white with a washboard appearance
  - Appearance on IR - range from medium gray to white and individual elements are often too small to be detected by the IR sensor

Billow Clouds

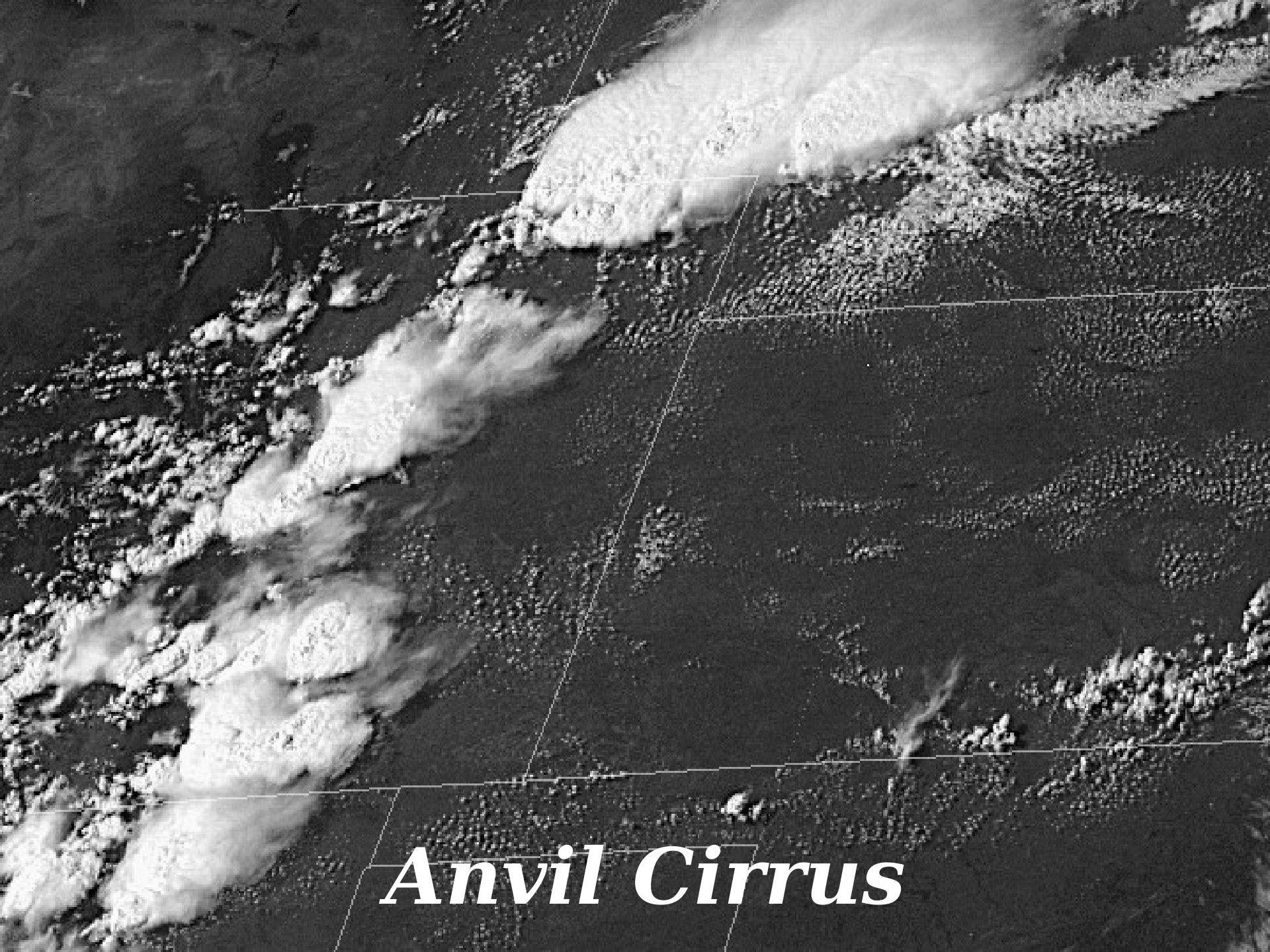


Billow Clouds

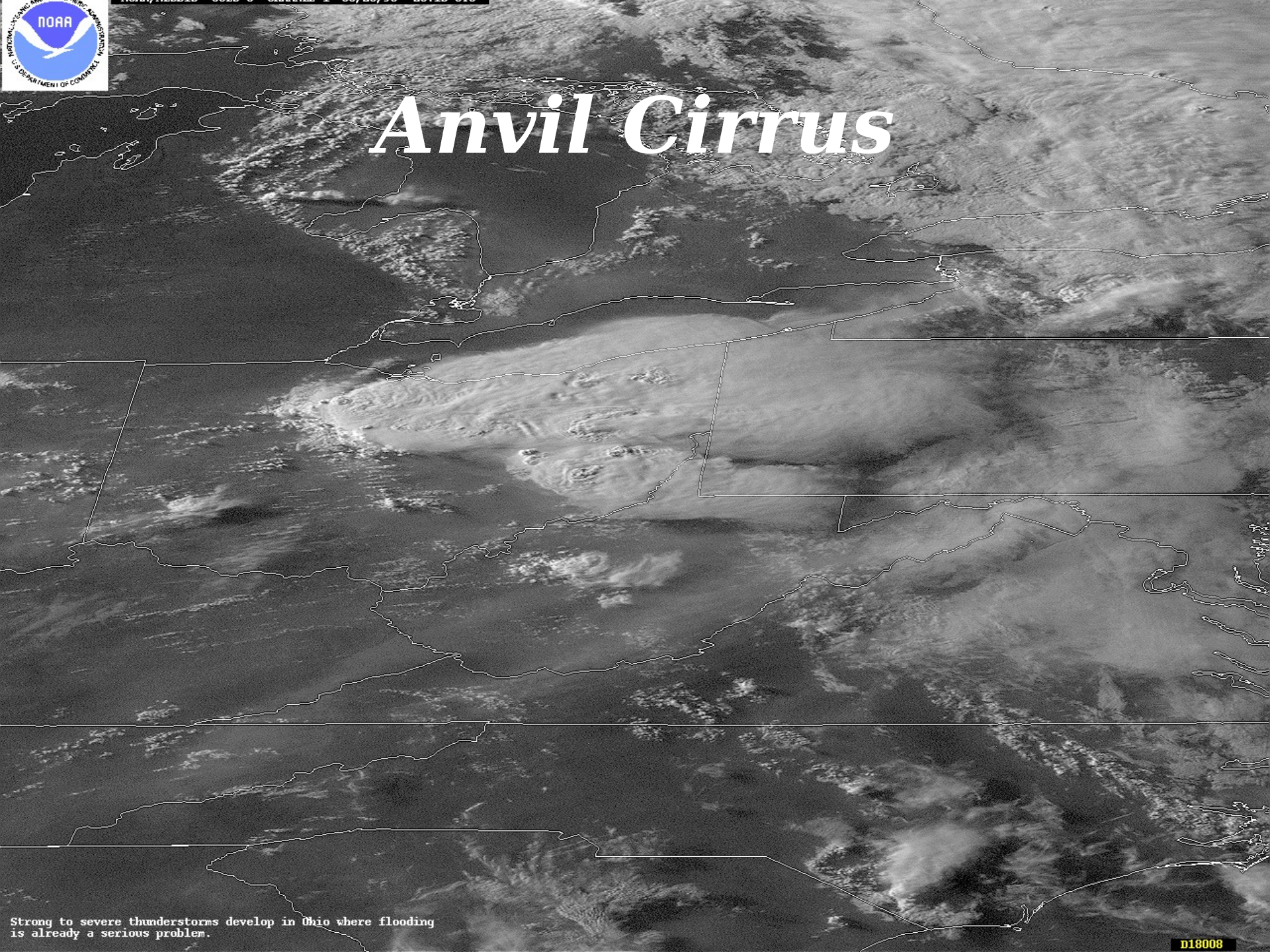


Cloud Identification

- Anvil Cirrus - blow off from thunderstorms and can form extensive cirrostratus cloud shield.
  - Appearance on VIS - well defined, bright white on upstream edge and darkens downstream; generally smooth except for overshooting tops.
  - Appearance on IR - bright white patches Enhanced imagery will assist in determining cloud heights.


Anvil Cirrus

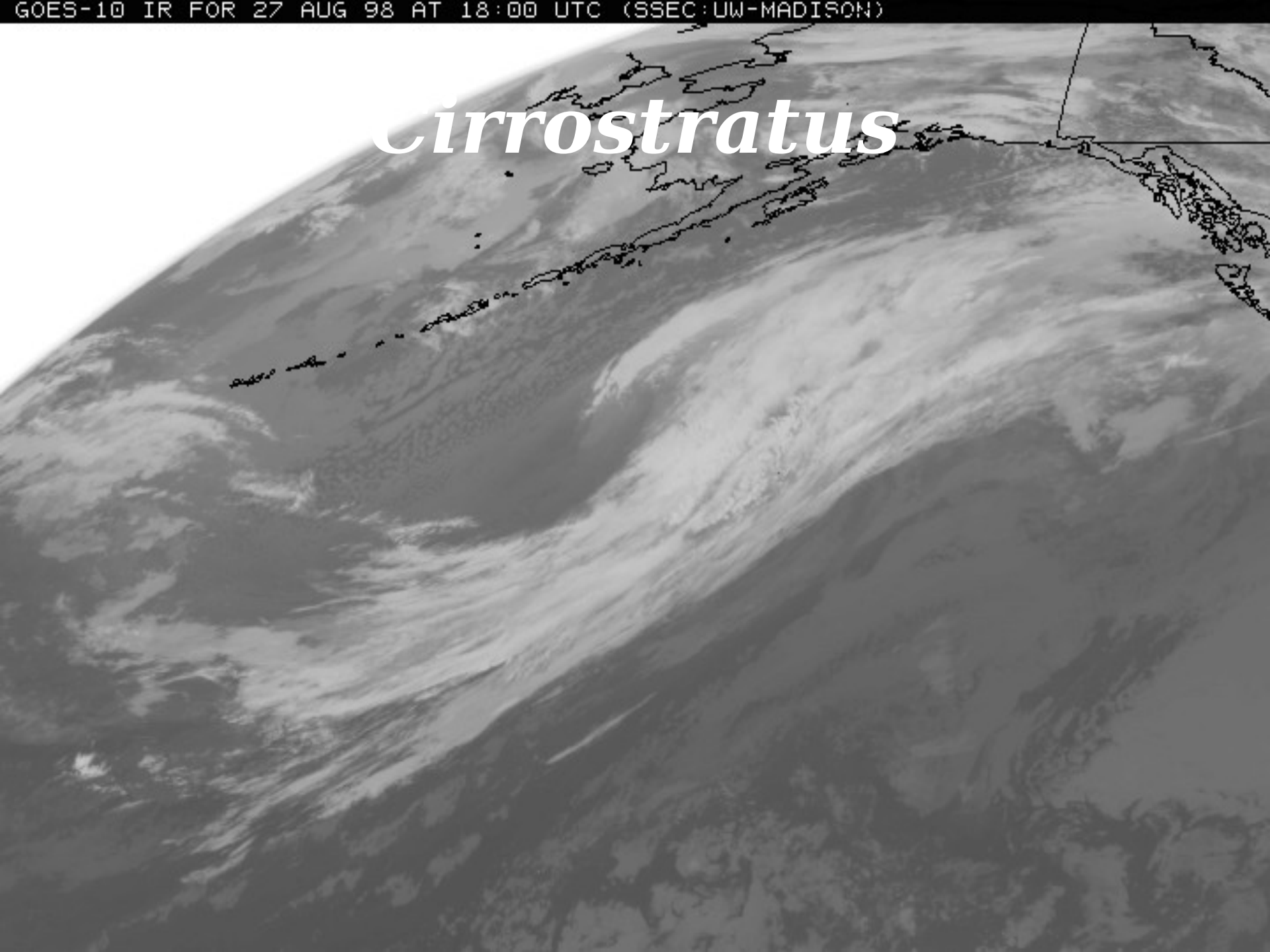
Anvil Cirrus

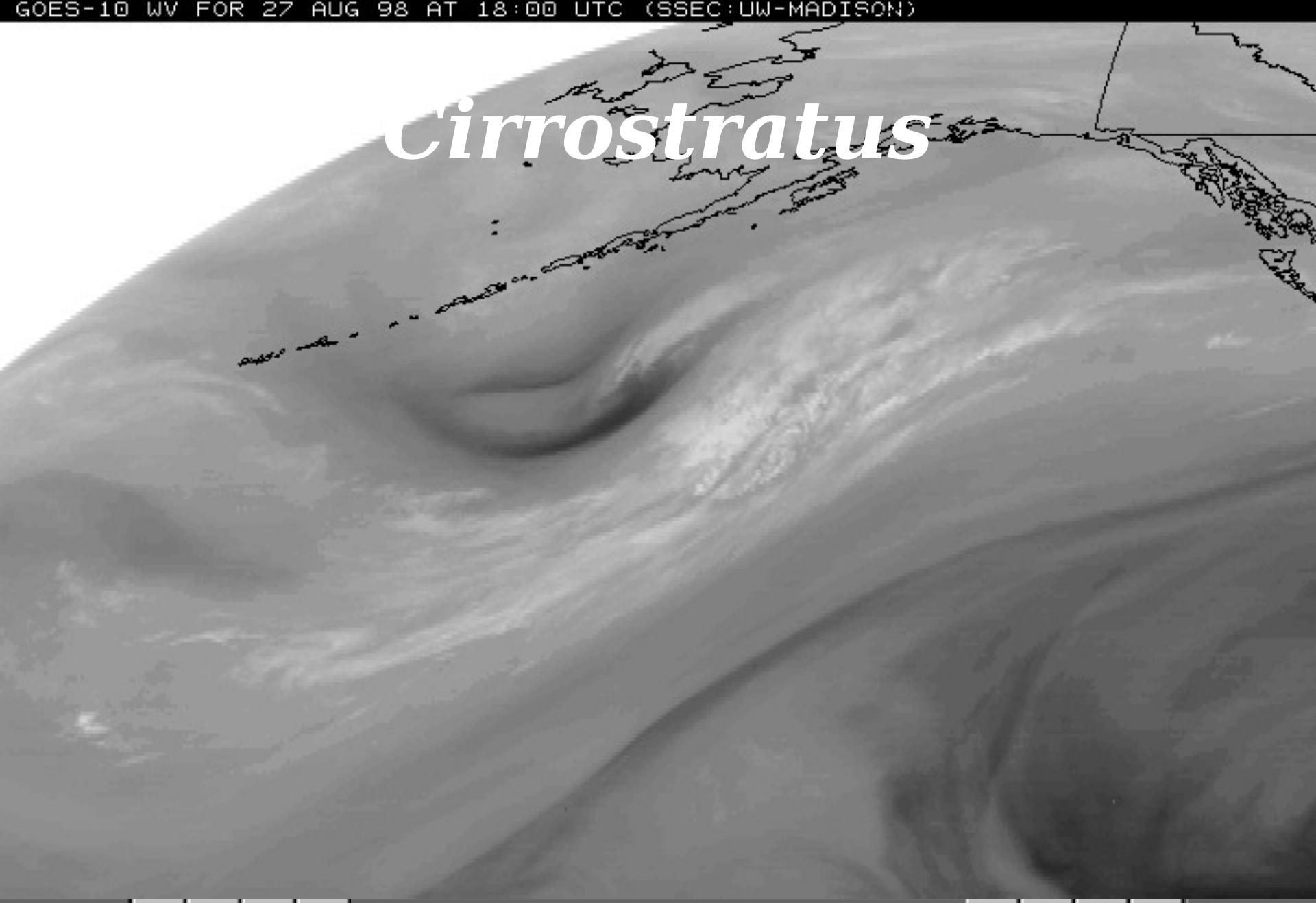

Anvil Cirrus
Strong to severe thunderstorms develop in Ohio where flooding is already a serious problem.
D18008

Cloud Identification

- Cirrostratus
  - Appearance on VIS
    - It appears bright white
    - Cirrostratus is thick, fairly uniform except along the edges where it will be thin and wispy
    - CS often casts shadows on lower clouds
  - Appearance on IR - uniform white (unenhanced) or enhanced to indicate cold tops
  - Appearance on WV - uniform bright white, covering extensive areas

GOES-10 VIS FOR 27 AUG 98 AT 18:00 UTC (SSEC:UW-MADISON)
Cirrostratus


GOES-10 IR FOR 27 AUG 98 AT 18:00 UTC (SSEC:UW-MADISON)
Cirrostratus

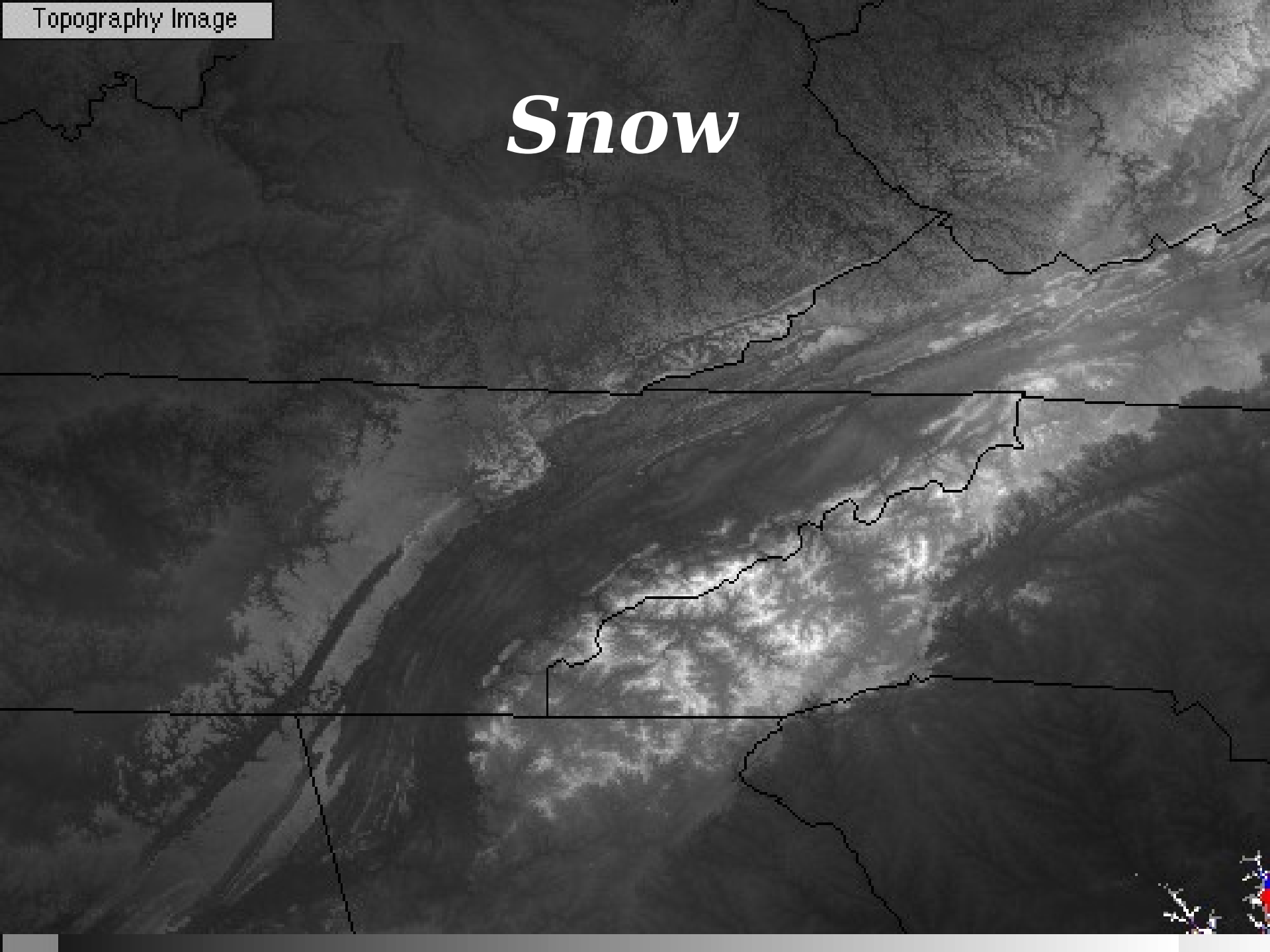


Determine cloud features on February 20

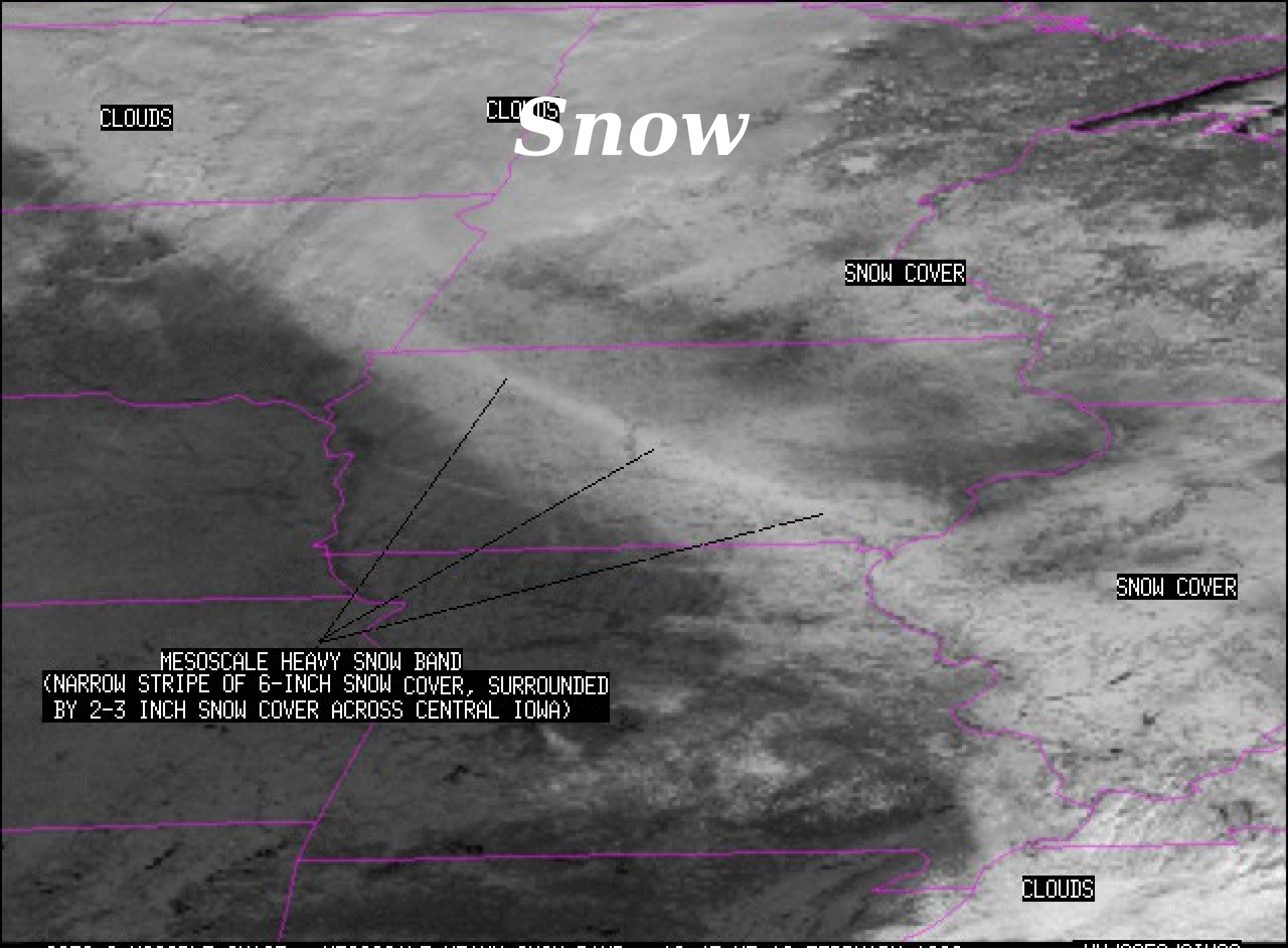
Cloud Identification

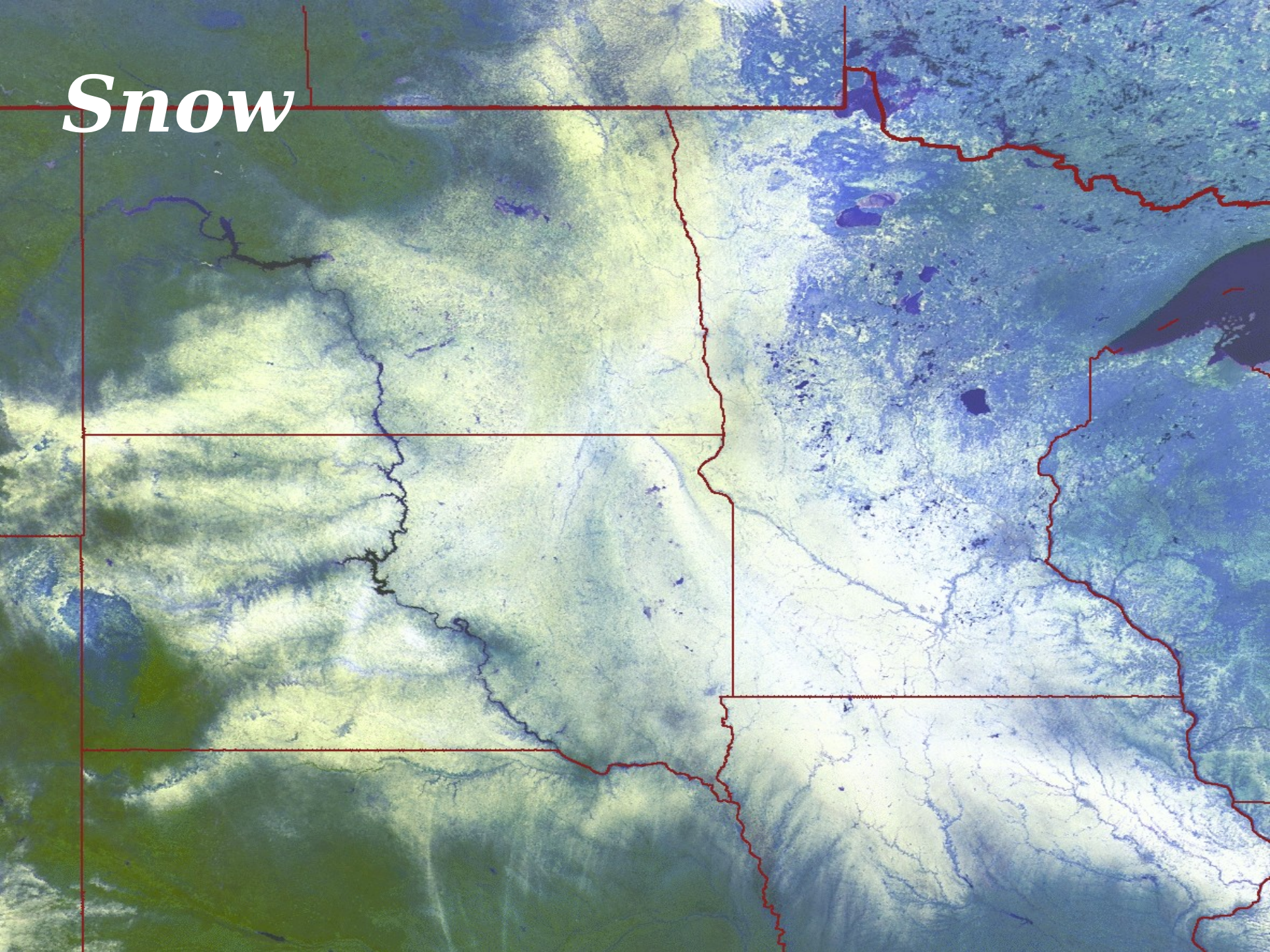
- Non-Cloud Features
  - Snow covered ground
    - Appearance on VIS - detects snow much better than IR because of the brightness contrast between the reflective snow field and the surrounding bare ground
      - Snow has a dendritic vein-like pattern in mountain areas
      - Rivers and lakes are sometimes snow free
      - Snowfields over flat regions tend to be long, narrow, and smooth with sharp edges

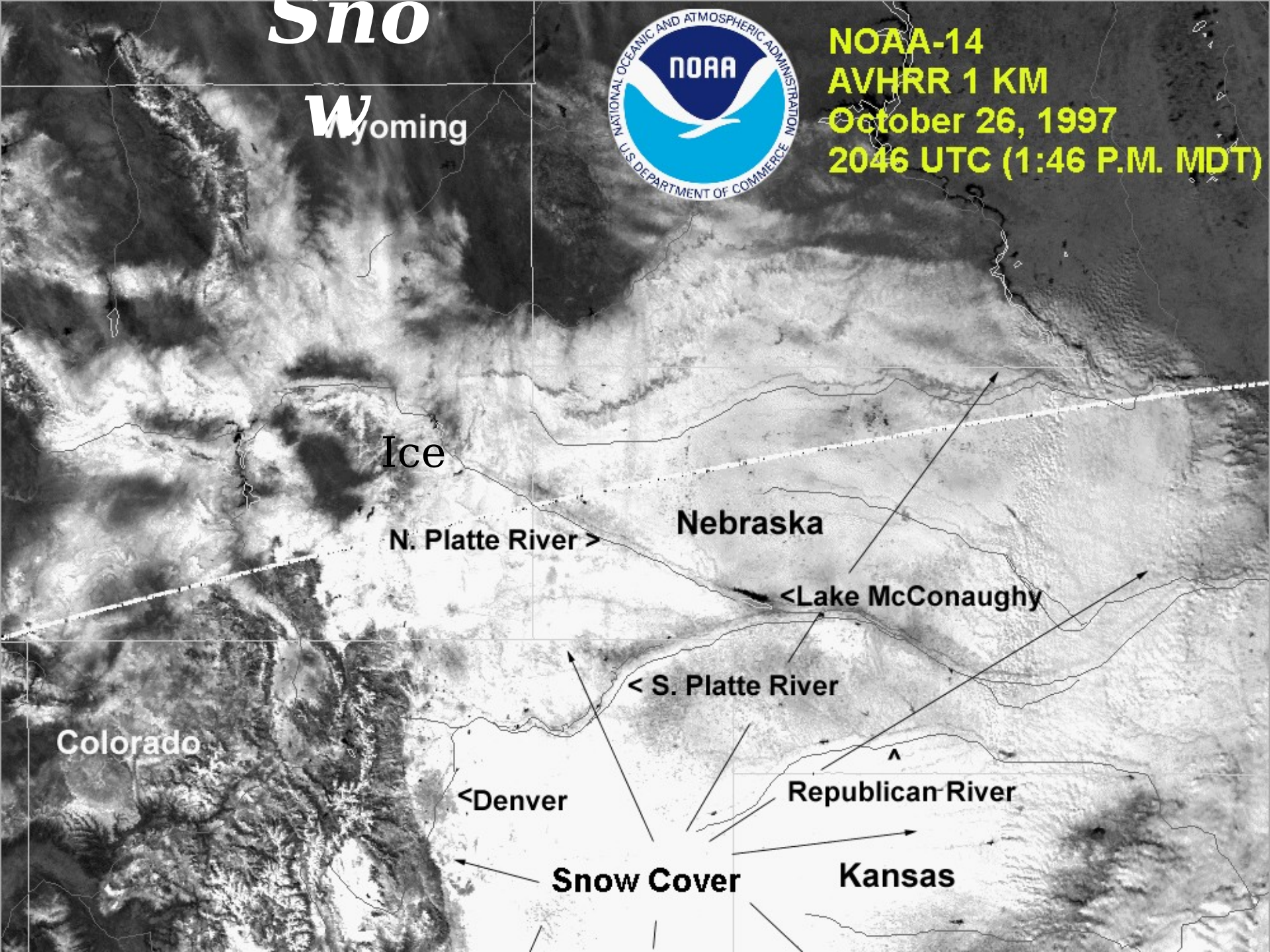
Non-cloud Features


Topography Image
Snow

Snow
0203 G-9 IMG 01 24 FEB 97055 201513 03192 16050 01.00
203


CLOUDS
CLOUDS
Snow
SNOW COVER
SNOW COVER
MESOSCALE HEAVY SNOW BAND
(NARROW STRIPE OF 6-INCH SNOW COVER, SURROUNDED
BY 2-3 INCH SNOW COVER ACROSS CENTRAL IOWA)
CLOUDS
GOES-8 VISIBLE IMAGE - MESOSCALE HEAVY SNOW BAND - 16:45 UT 16 FEBRUARY 1996
UW/SSEC/CIMSS


Snow


Sno
w
Wyoming
NOAA-14
AVHRR 1 KM
October 26, 1997
2046 UTC (1:46 P.M. MDT)
Ice
Nebraska
N. Platte River >
<Lake McConaughy
< S. Platte River
Colorado
<Denver
Republican River
Snow Cover
Kansas

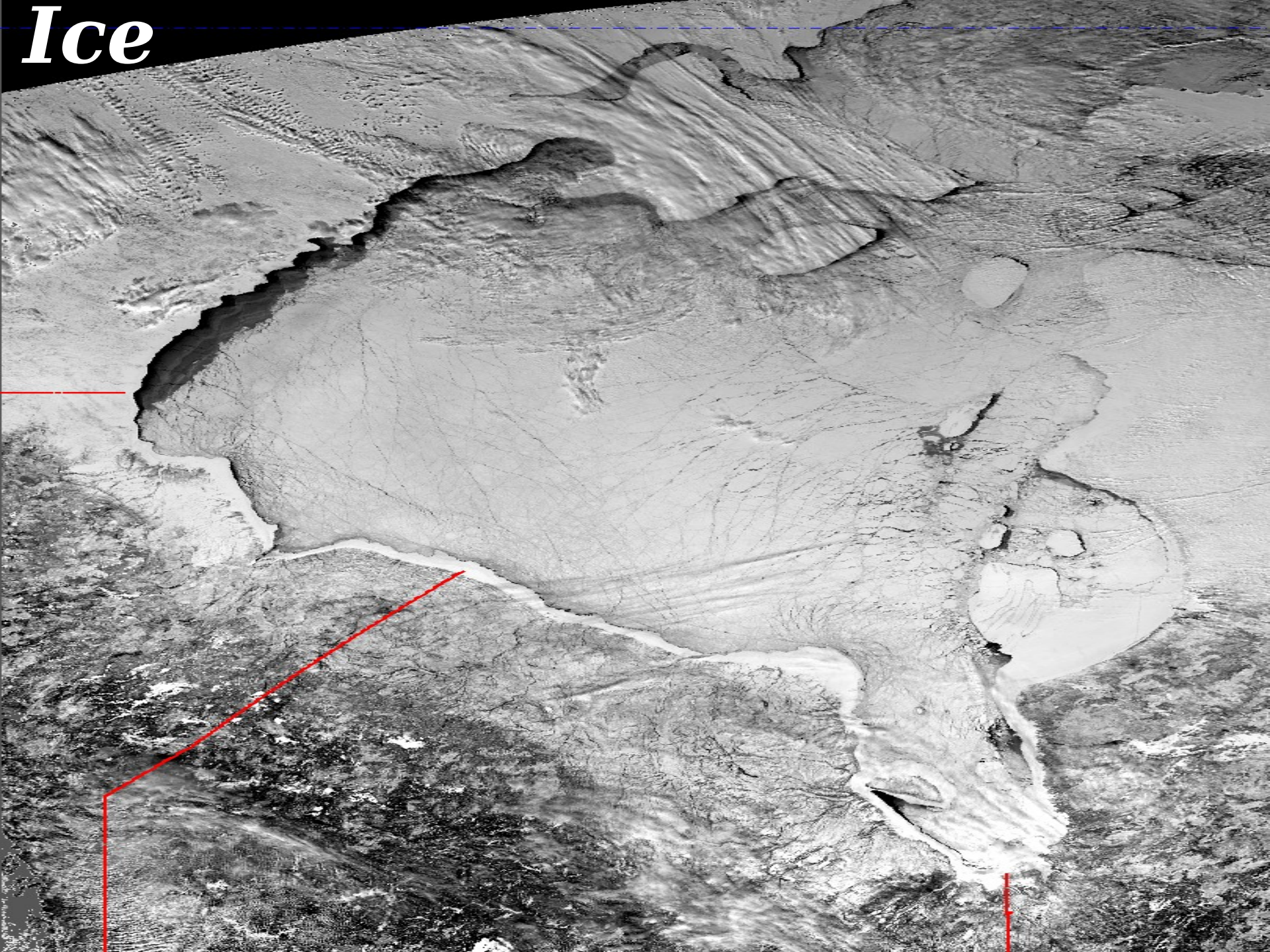
Cloud Identification

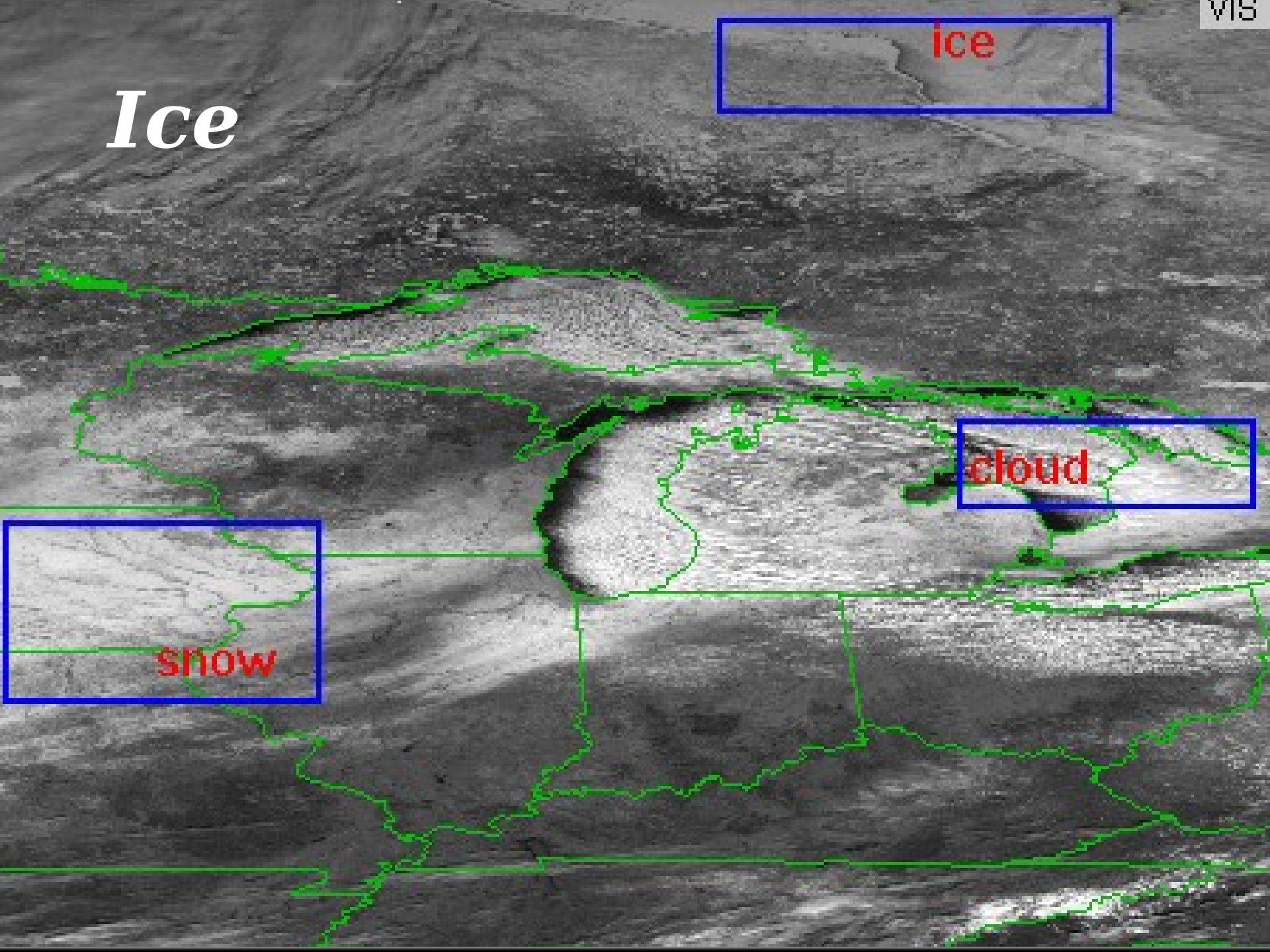
- Snow will have a mottled (blotchy) appearance in forested areas.
- It will be bright white in the plains and brightness decreases with increasing vegetation density and height.

– Appearance on IR - fresh snow will often appear colder than surrounding snow-free areas especially around sunrise.

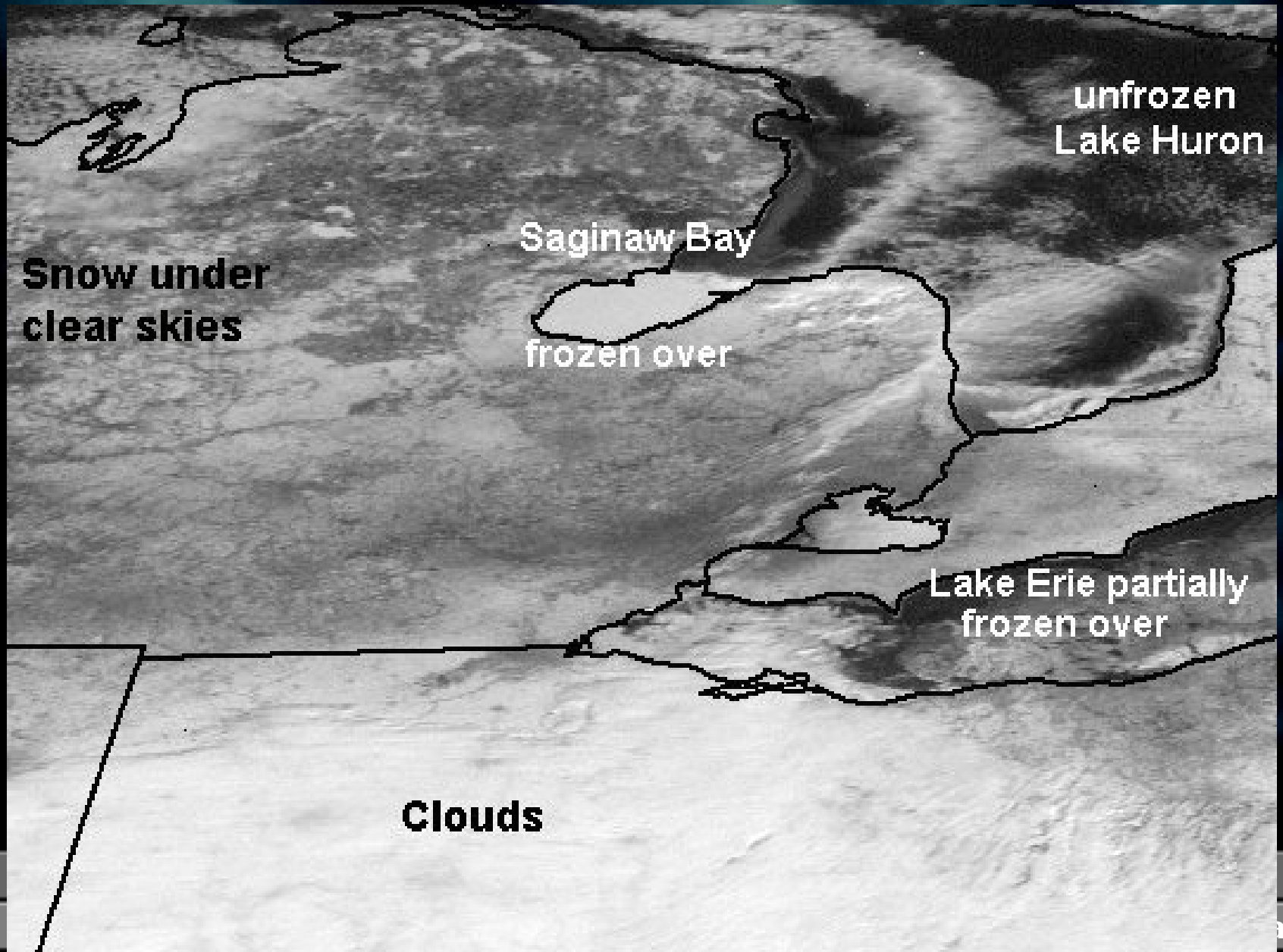
Cloud Identification

- Ice
  - Ice forms along shorelines and offshore winds often move the ice and break it up
  - Water and new, thin, transparent ice will appear as a dark band along the shore
  - Appearance on VIS - has the same gray shade as snow and is difficult to distinguish from snow cover except there may be dark fractures or cracks
  - Appearance on IR - has the same gray shade as snow and is difficult to distinguish from snow cover


Ice


Ice
ice
cloud
snow
VIS

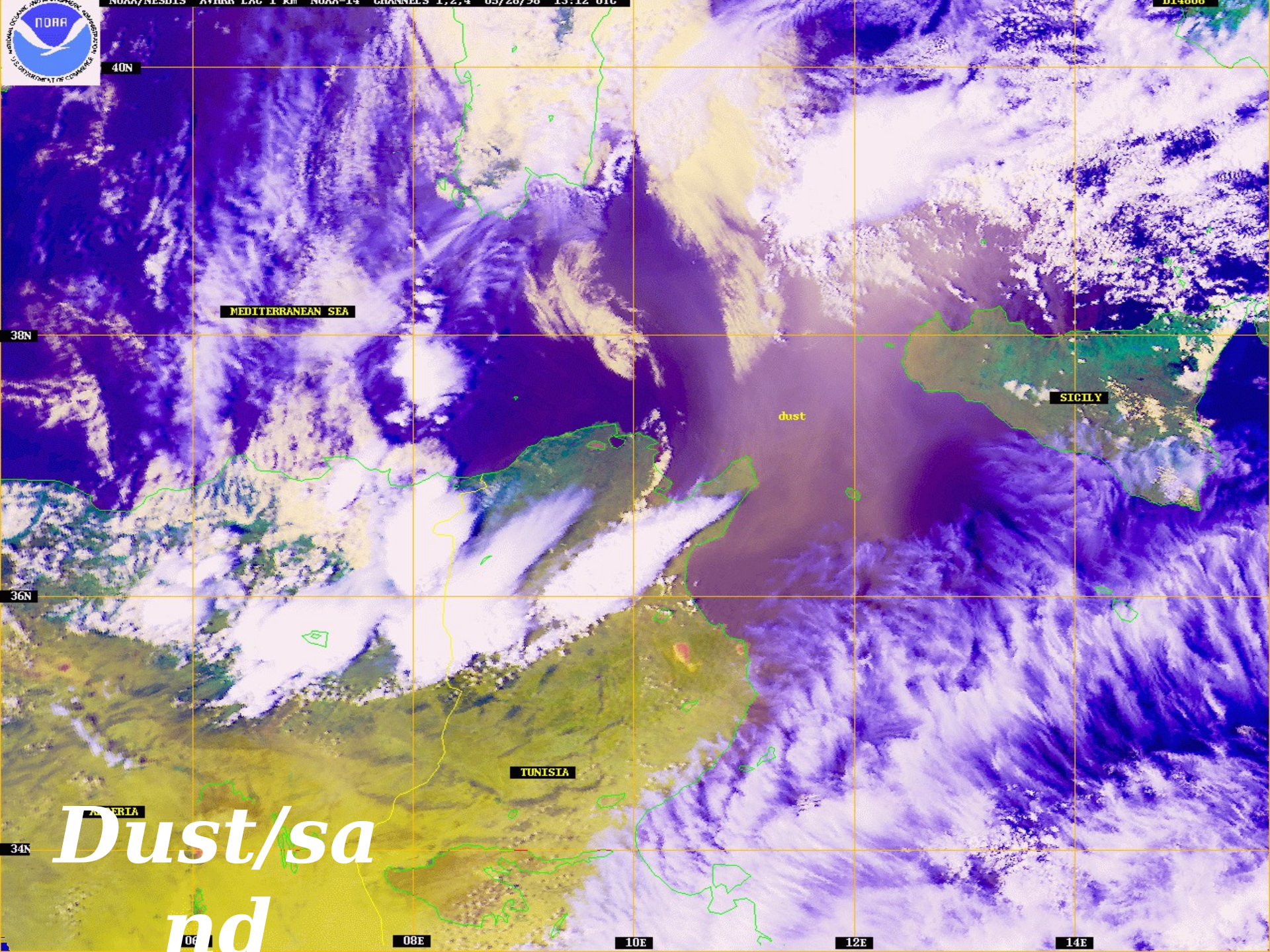
Snow and Ice


unfrozen
Lake Huron
Saginaw Bay
Snow under
clear skies
frozen over
Lake Erie partially
frozen over
Clouds

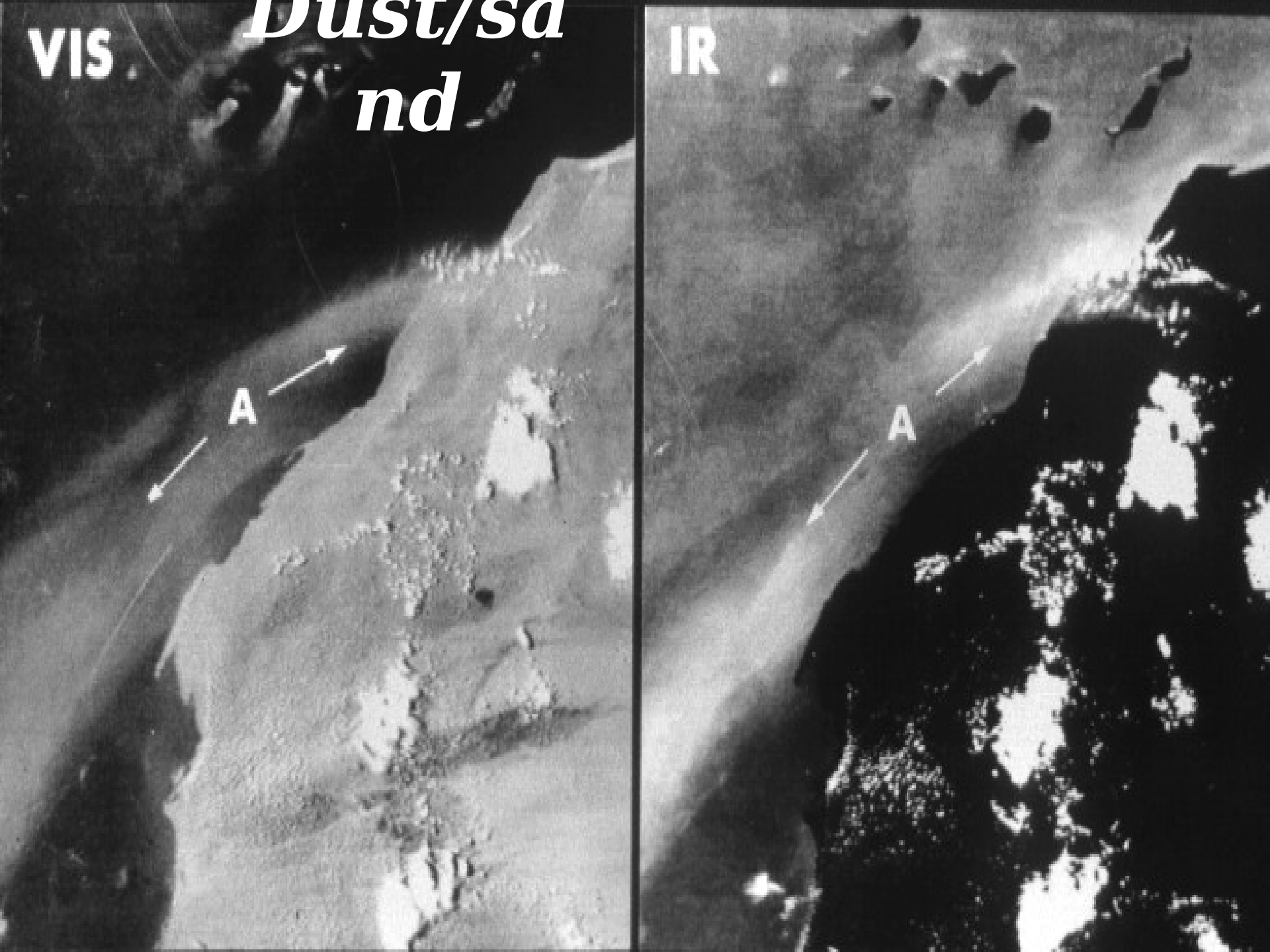
Snow Ice Cloud
Composite

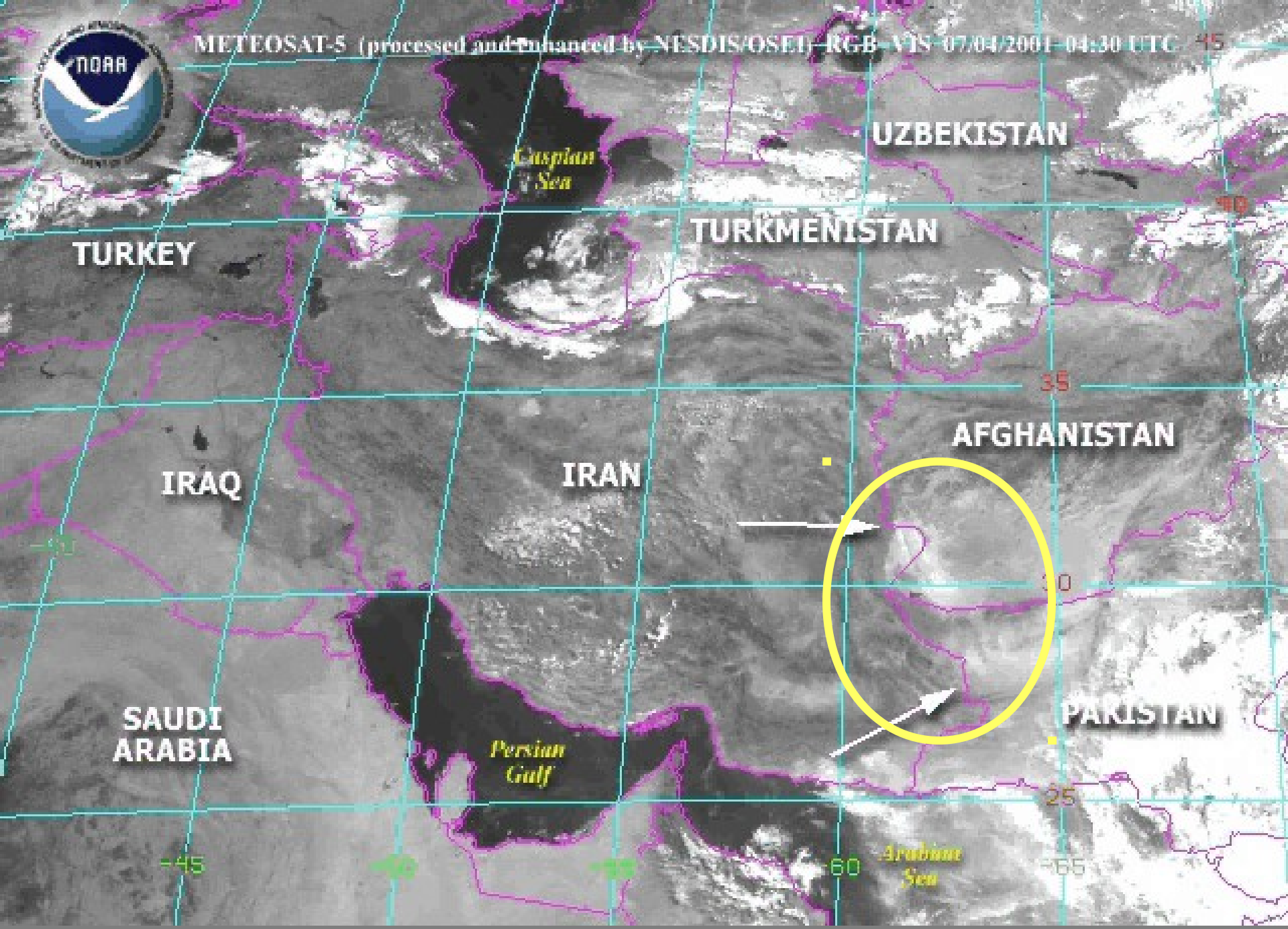
Cloud Identification

- Lithometeors
  - Dust/sand - suspended particles carried aloft by strong synoptic-scale surface winds are often carried long distances and common in desert regions
    - Appearance on VIS - diffuse area of a medium to light gray and the upstream edge usually is not well defined
    - Appearance on IR - the temperature contrast between the suspended particles and the surface is usually too small to be detected by the IR sensor


NOAA/NESDIS AVHRR LAC 1 km NOAA-14 CHANNELS 1,2,4 05/28/98 13:12 UTC
40N
MEDITERRANEAN SEA
38N
SICILY
dust
36N
TUNISIA
34N
08E
10E
12E
14E

Dust/sa nd

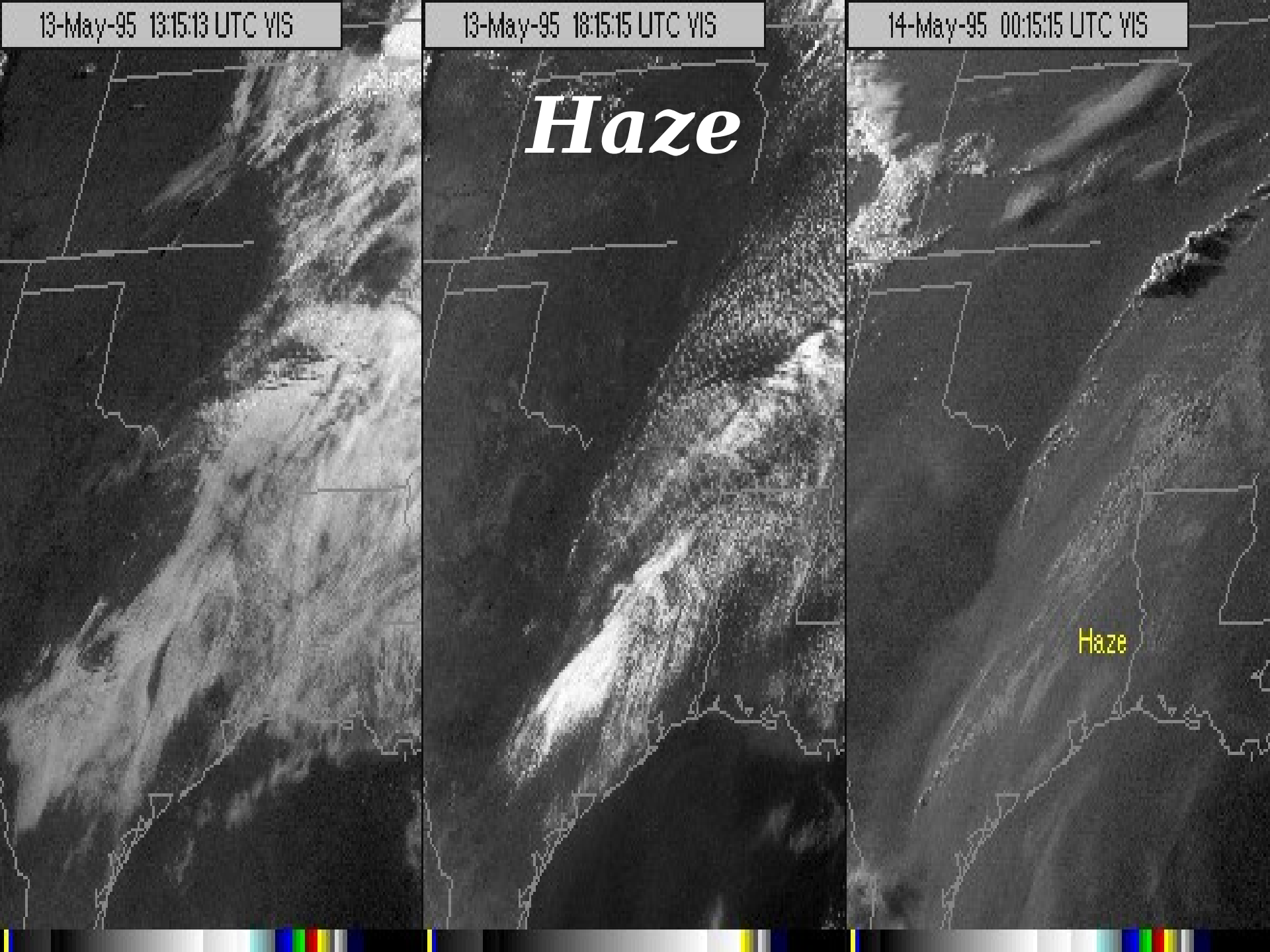

VIS
Dust/sa
nd
A
IR
A



Determine cloud features on February 20

Cloud Identification

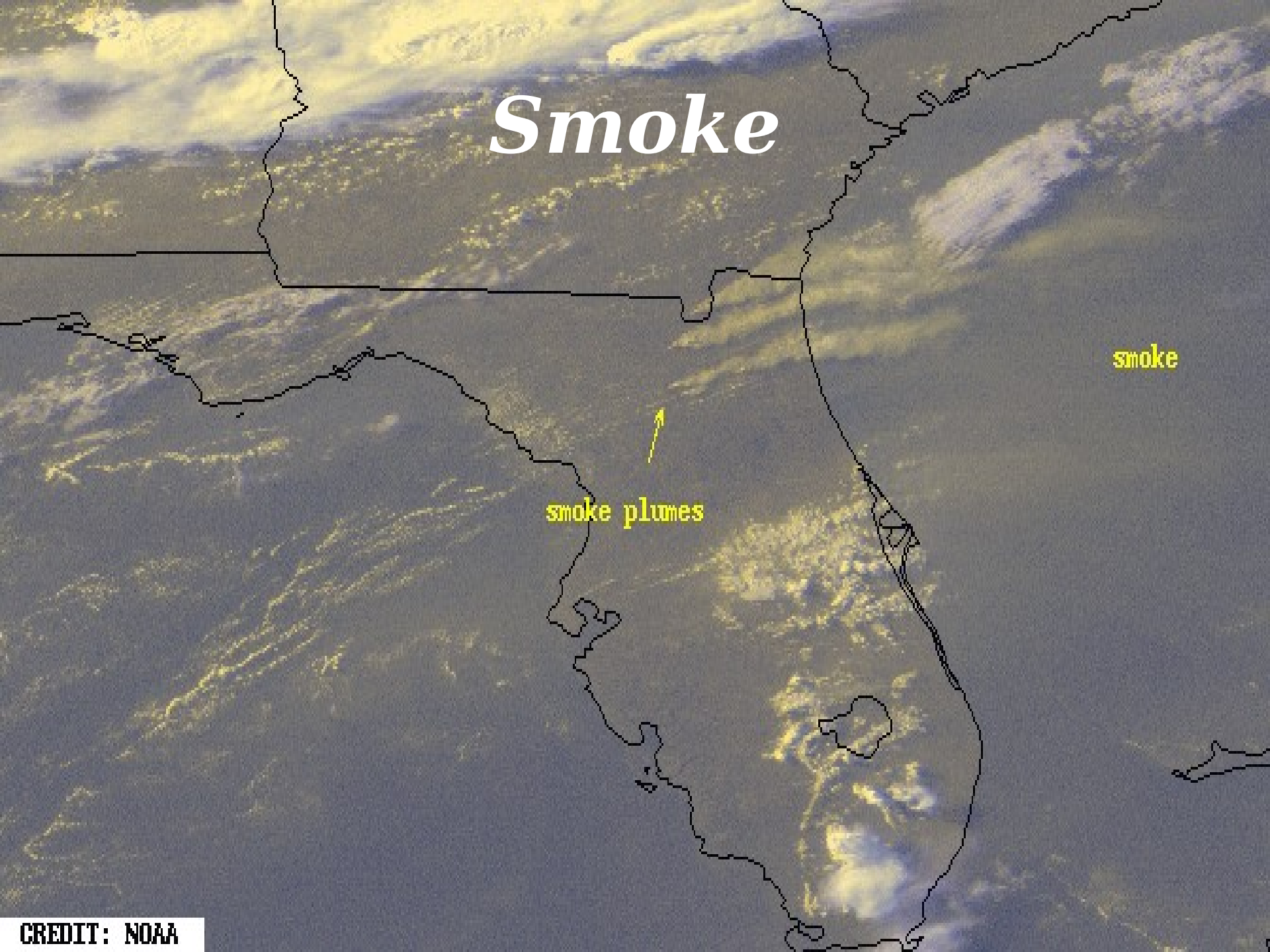
- Haze - forms under stagnant, anticyclonic flow where particles are trapped under the inversion which may exist for several days to a week
  - Appearance on VIS - milky over the affected area, almost like thin cirrus
  - Appearance on IR - shows warmer temps (below the inversion), ruling out cirrus

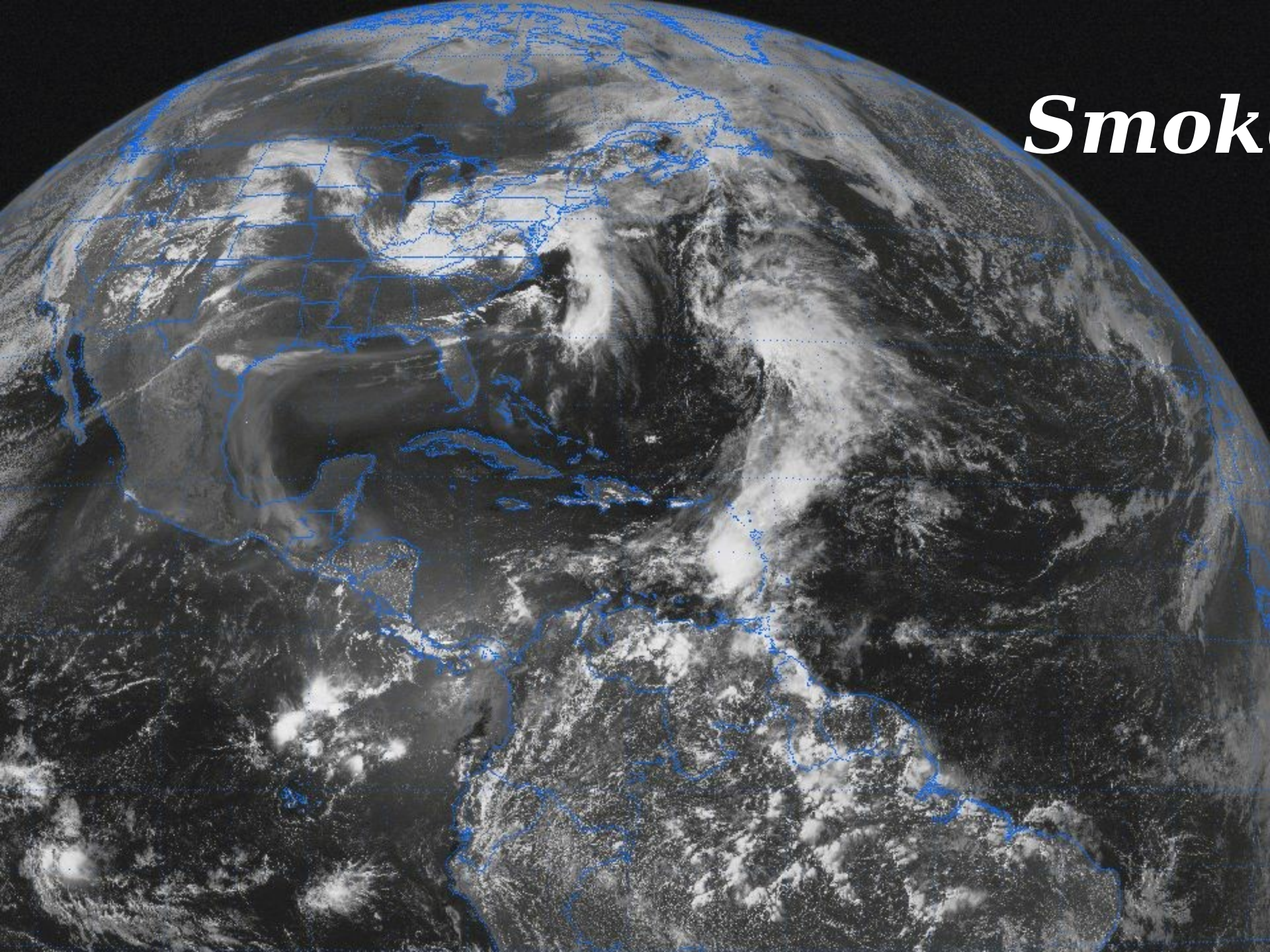

13-May-95 13:15:13 UTC VIS
13-May-95 18:15:15 UTC VIS
Haze
14-May-95 00:15:15 UTC VIS
Haze

Cloud Identification

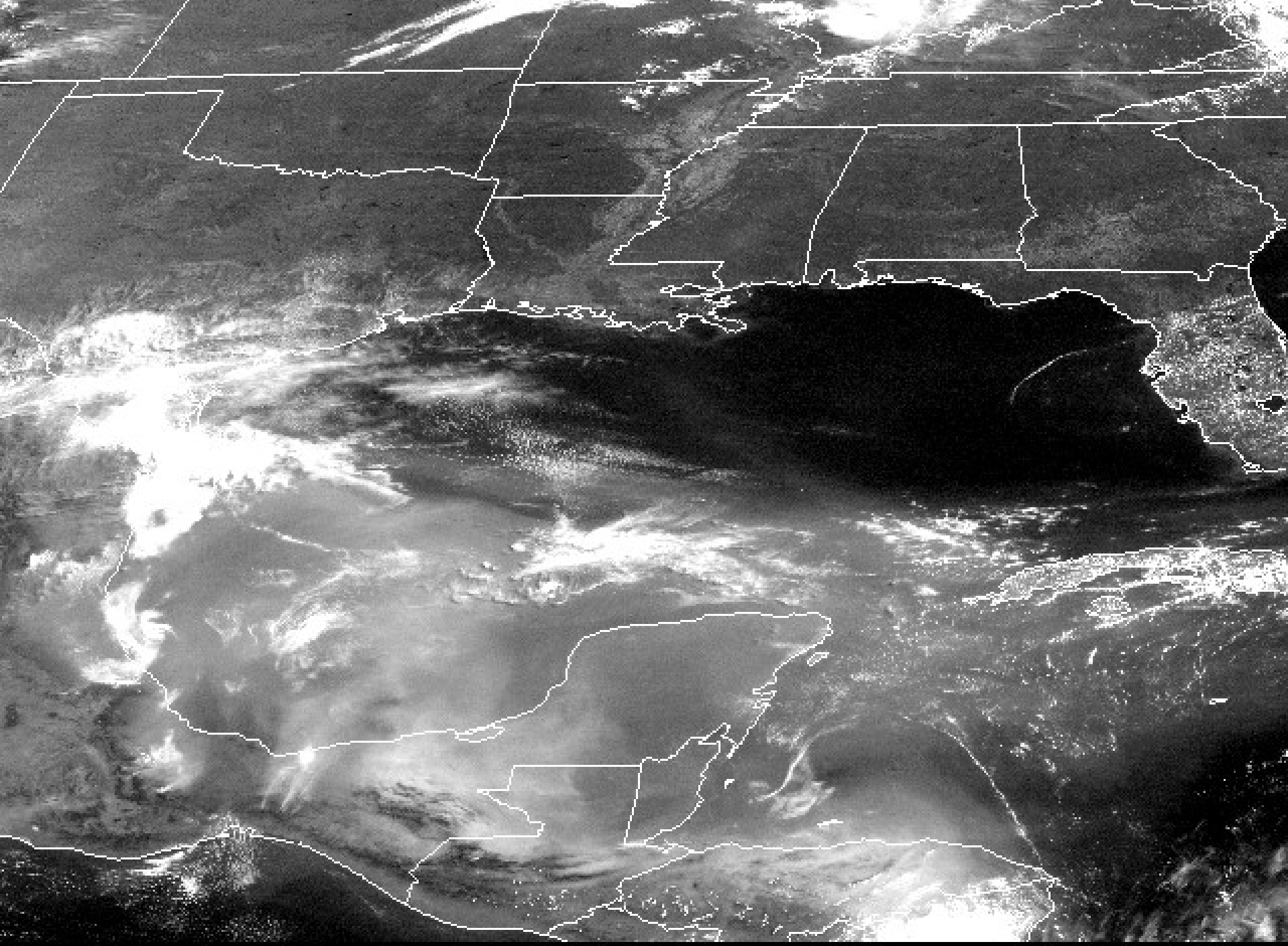
- Smoke/ash - smoke and ash from fires and industry usually have a sharp boundary at the source of the plu me
  .
  - Smoke and ash from, volcanoes may be discernible depending on the level of volcanic activity.
    - » Volcanic ash reaches ambient air temperature very rapidly.
    - » If a volcanic plume reaches high altitudes, the ash cloud will appear cold on the IR imagery.

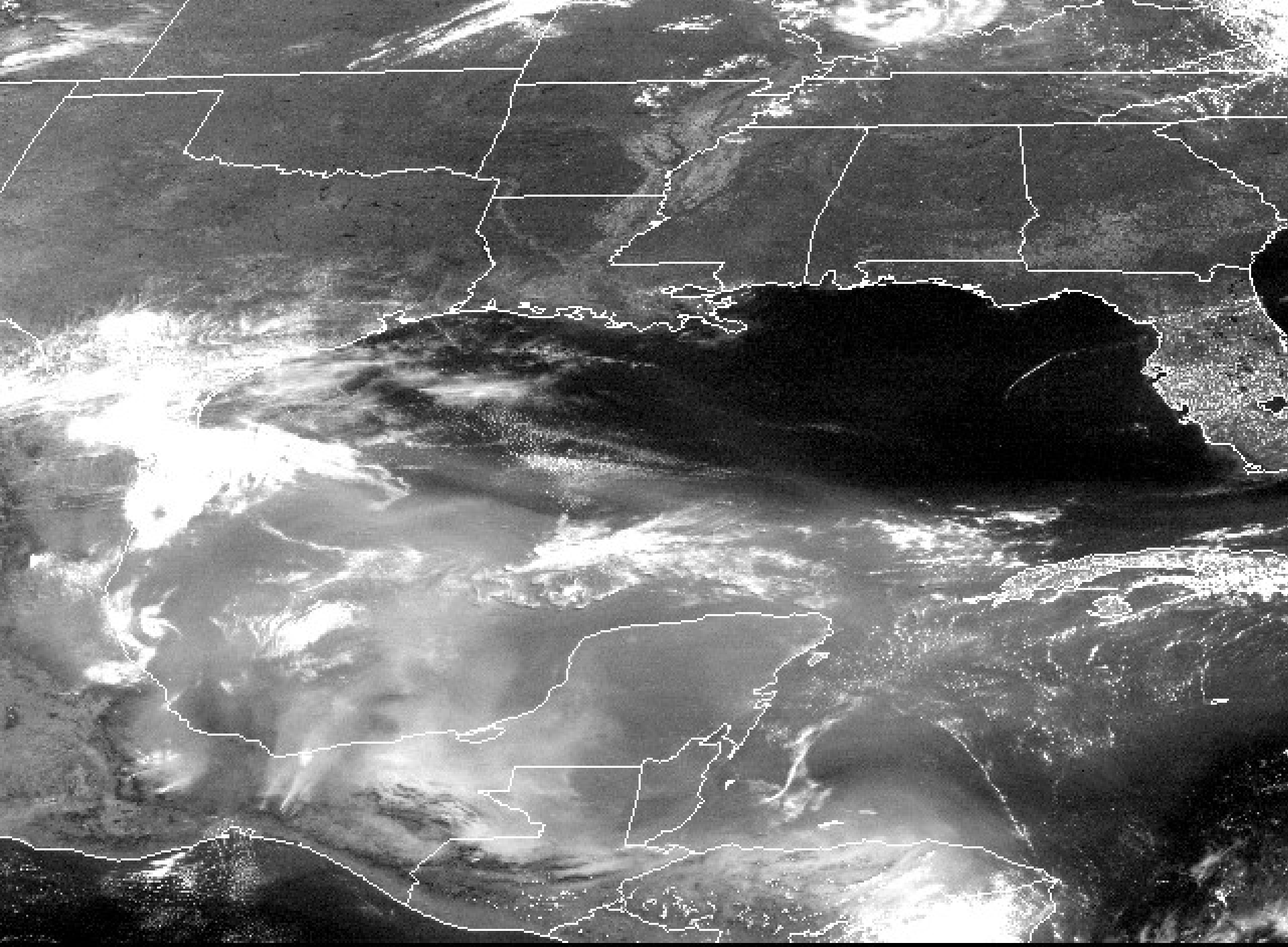
Smoke

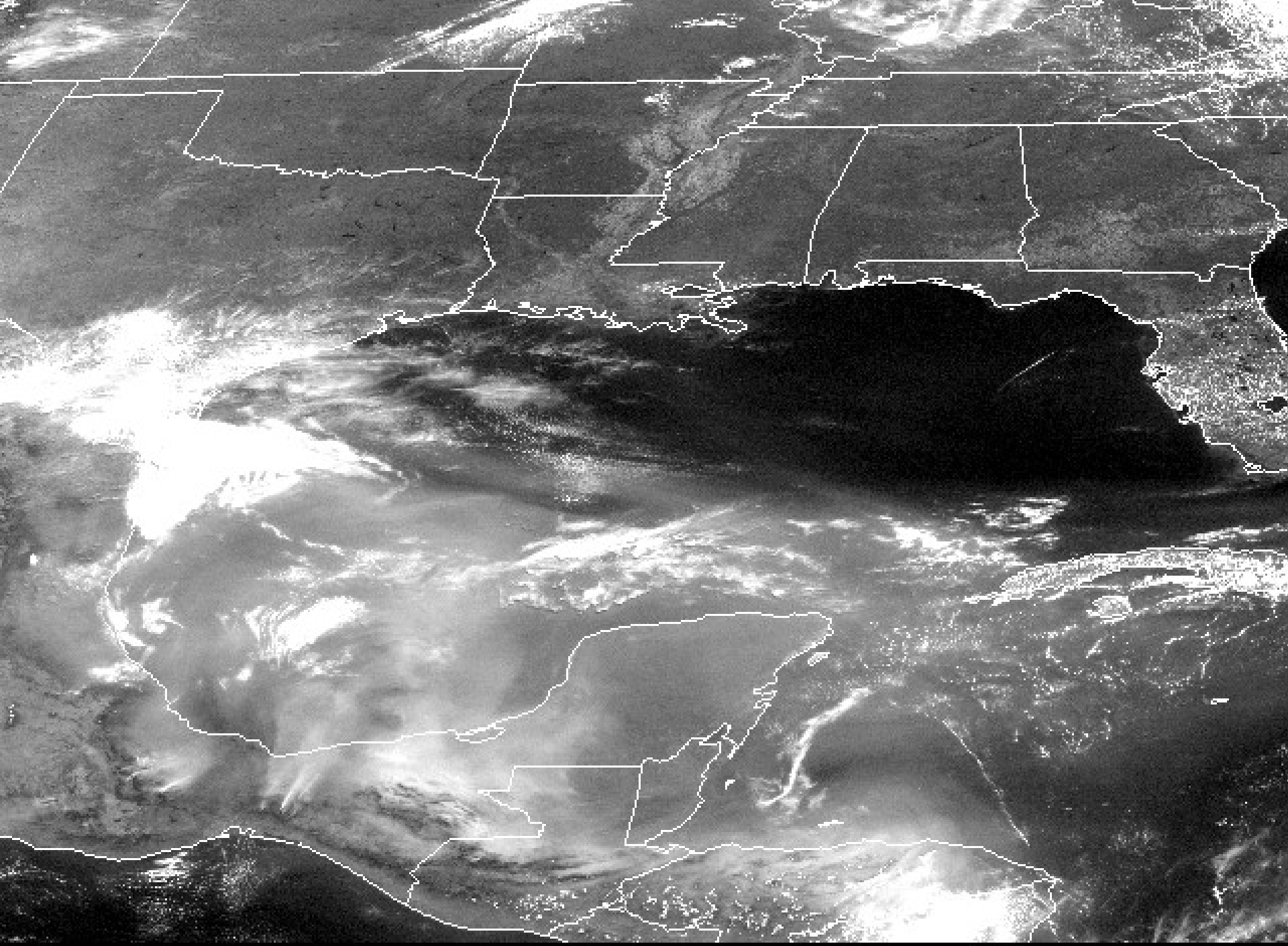

Smoke
smoke
smoke plumes
CREDIT: NOAA

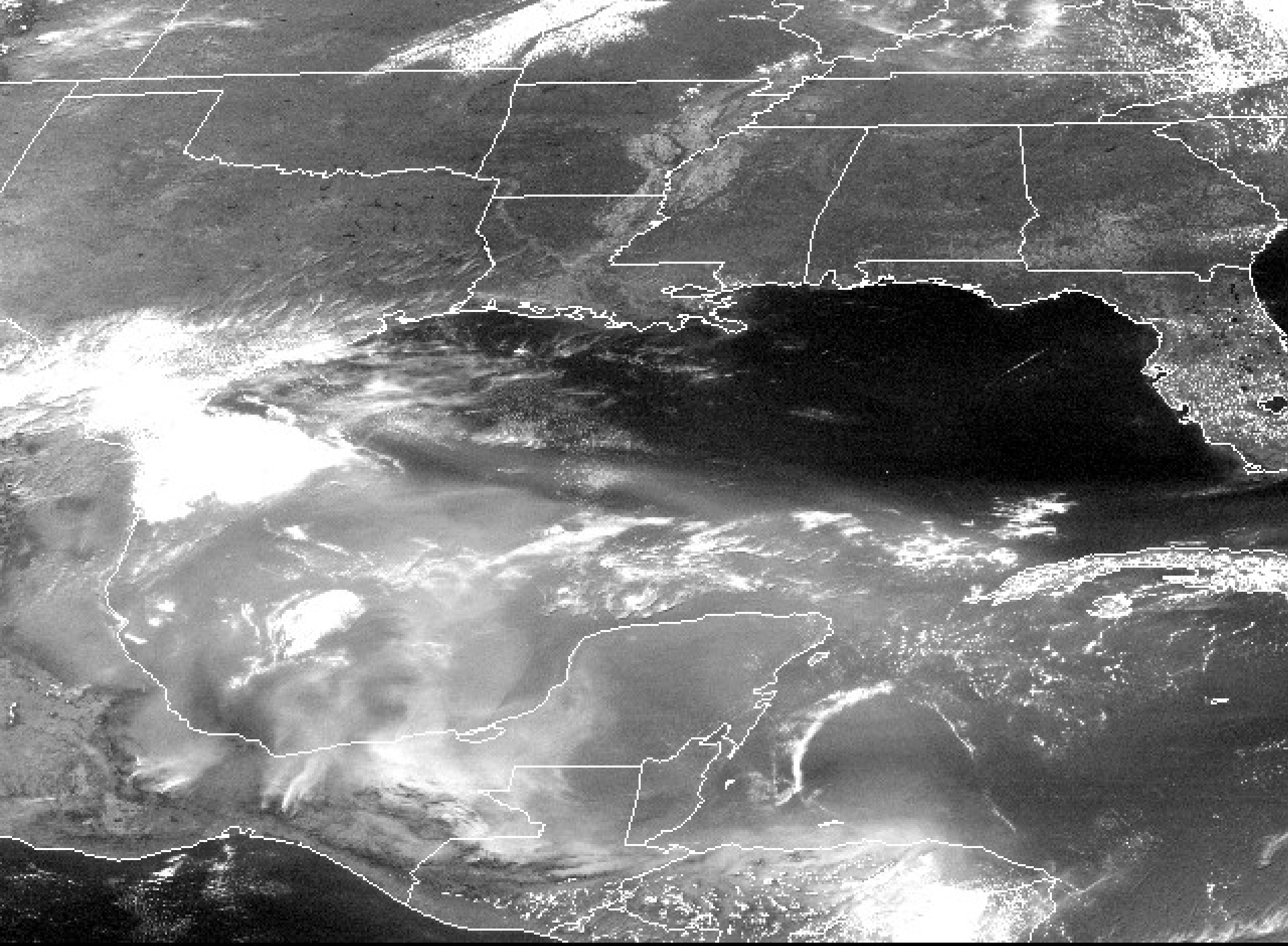

Smok

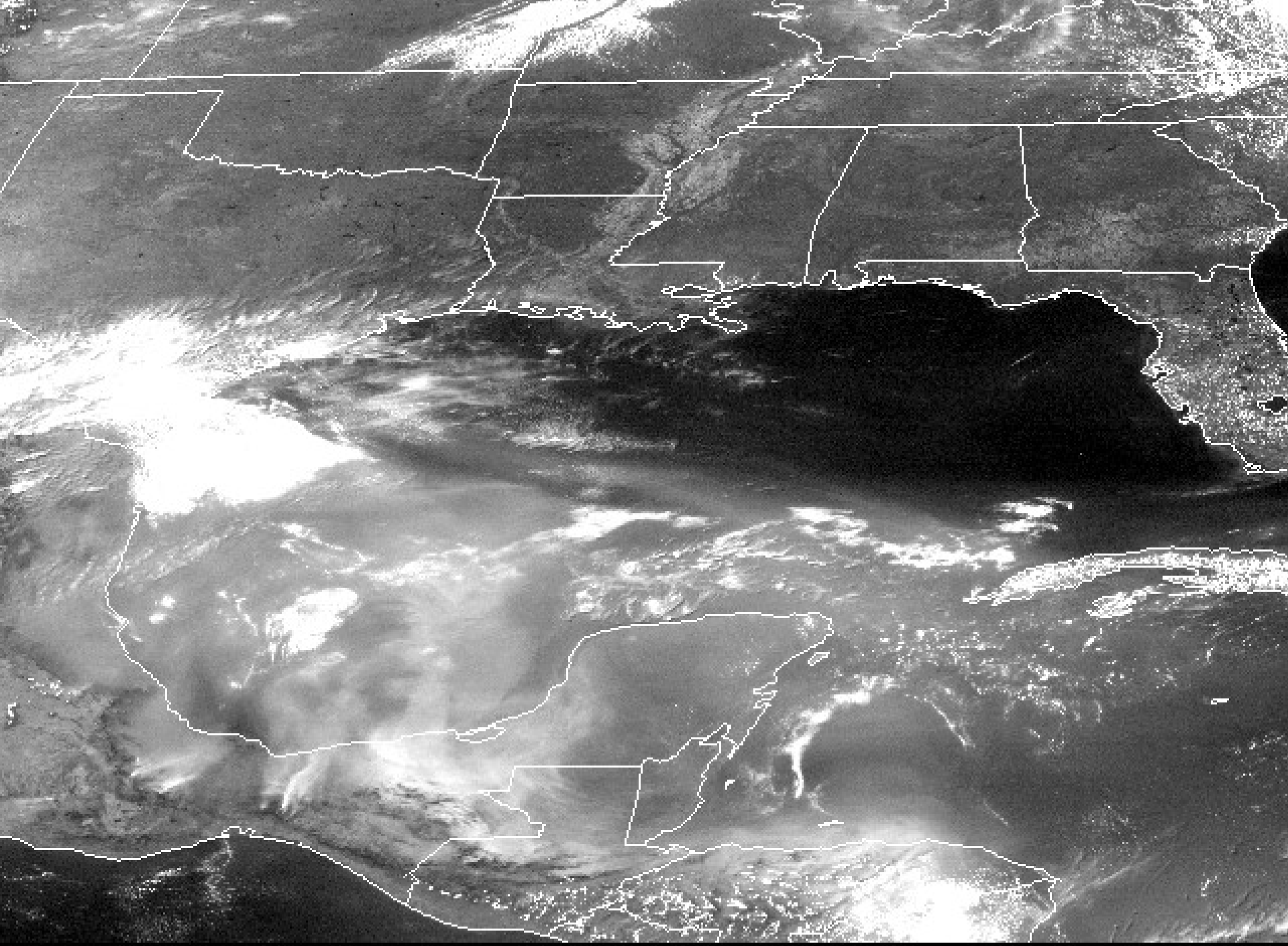
Smoke Animation

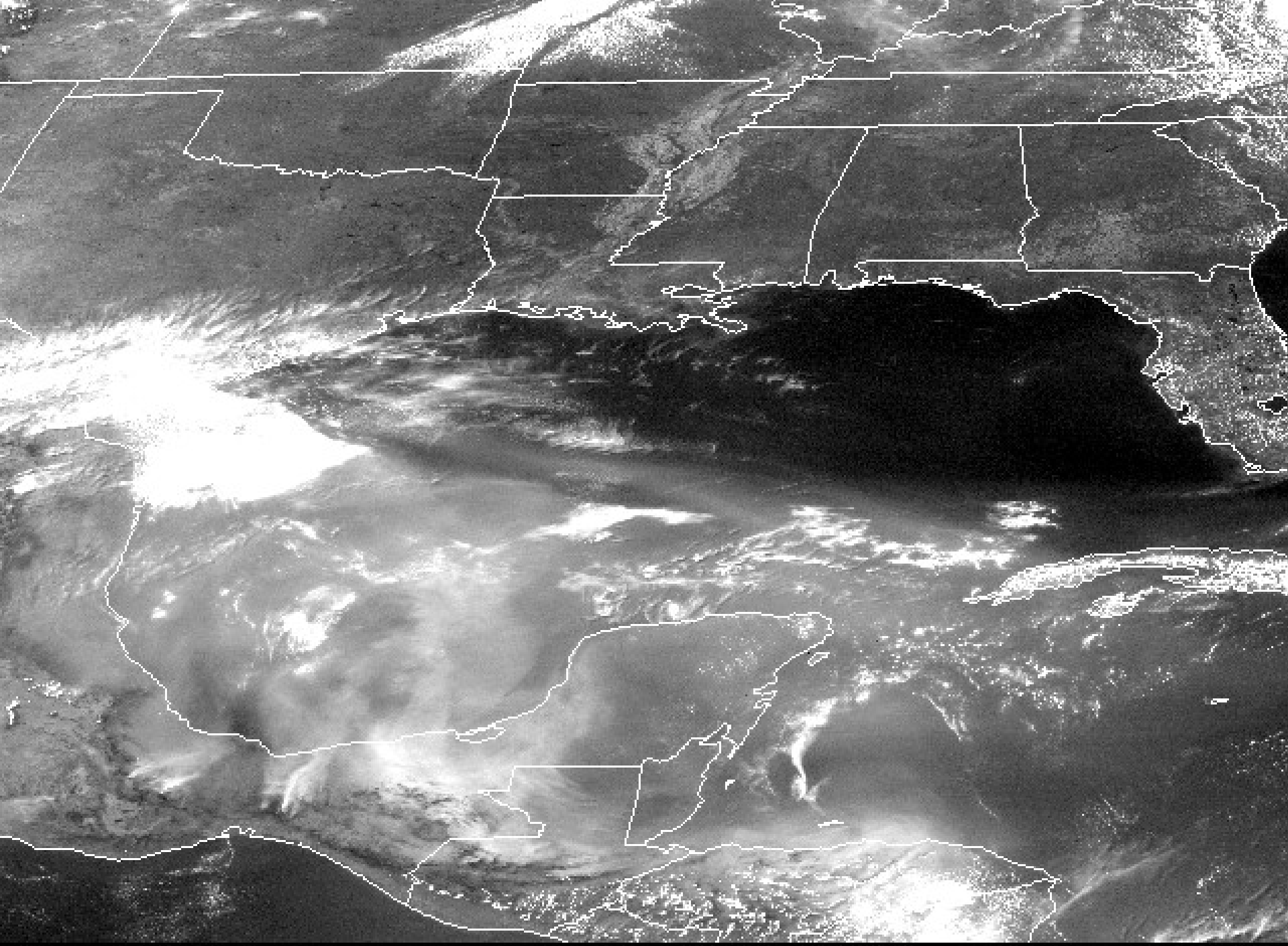


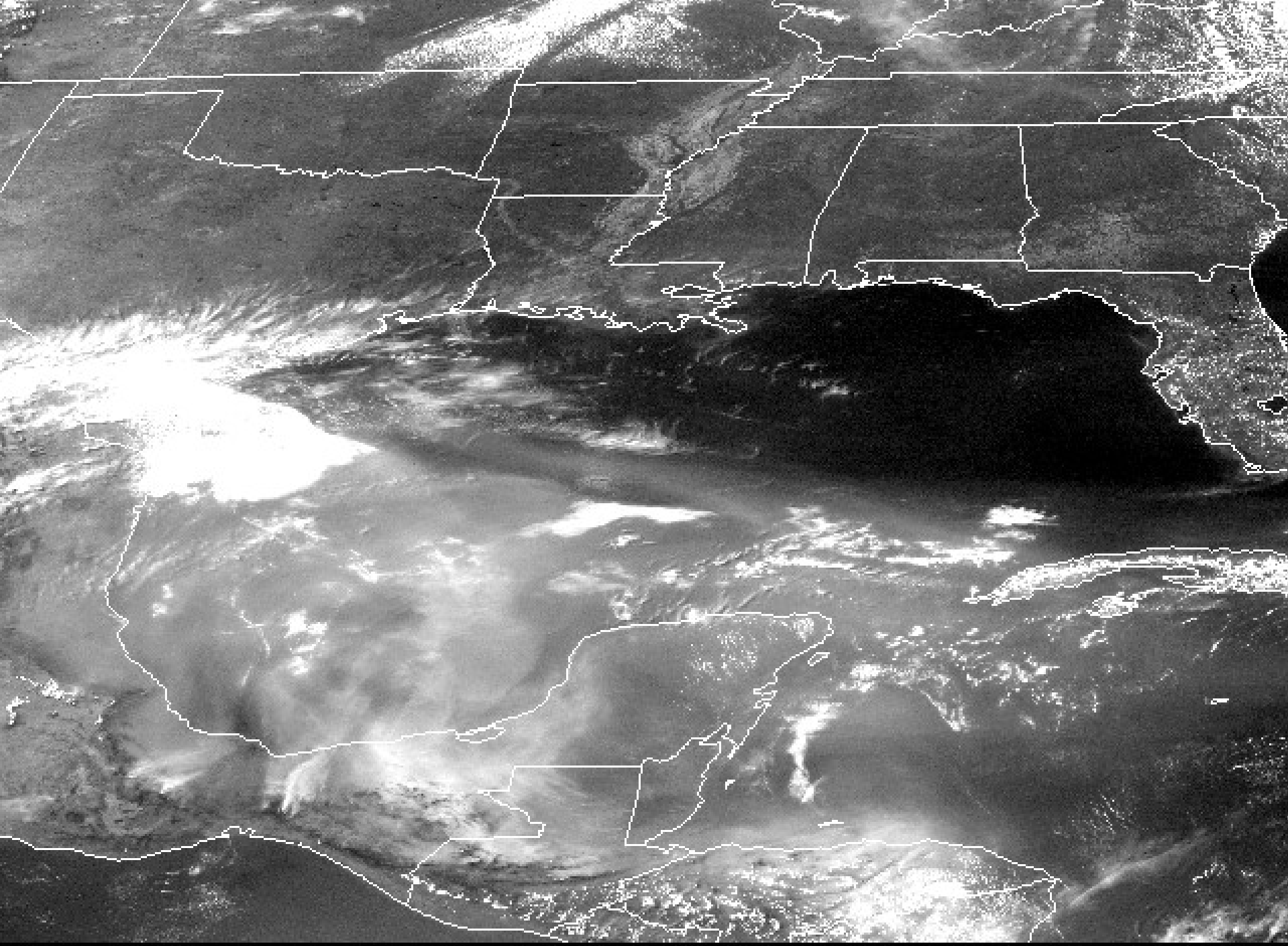


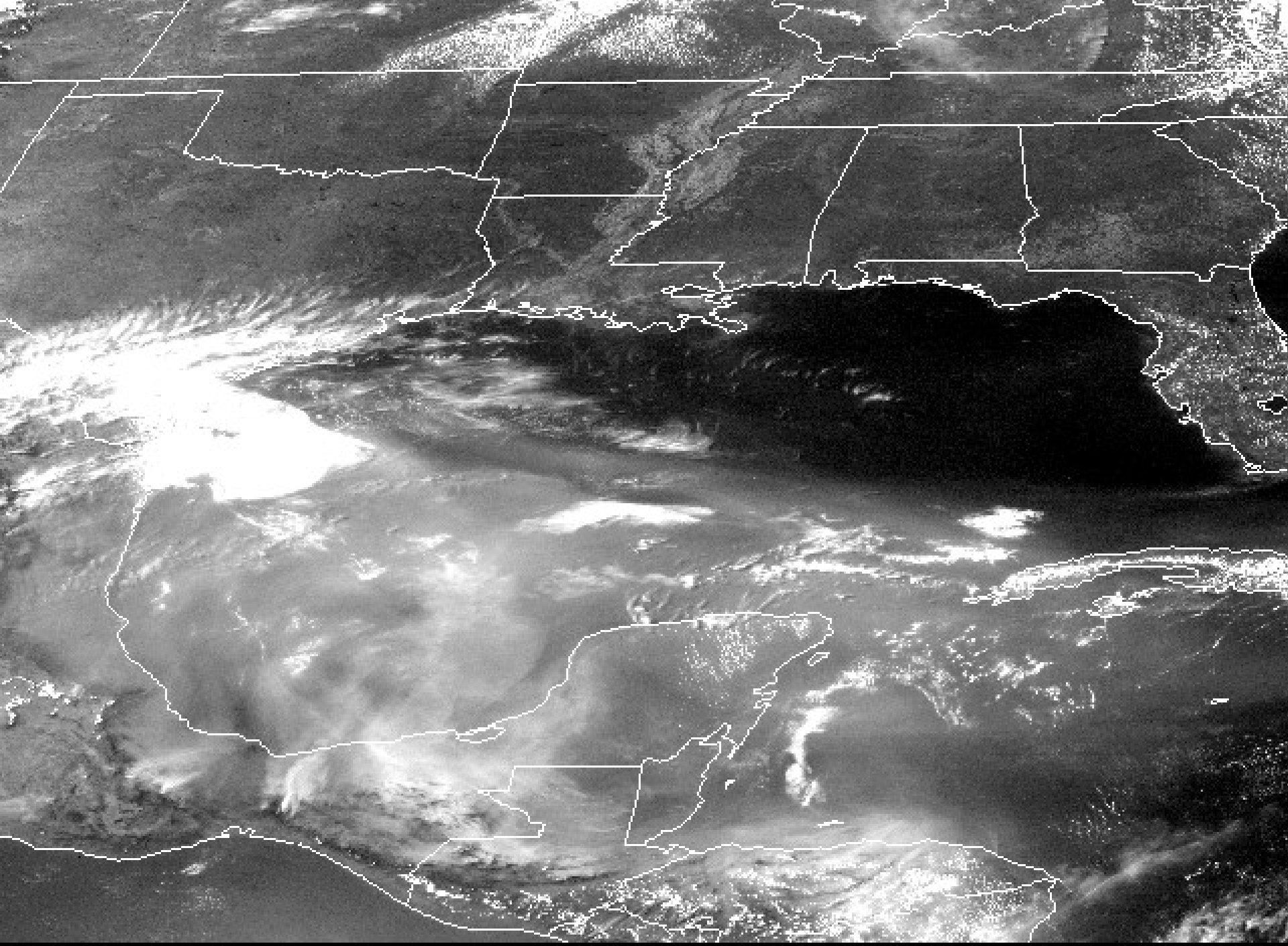


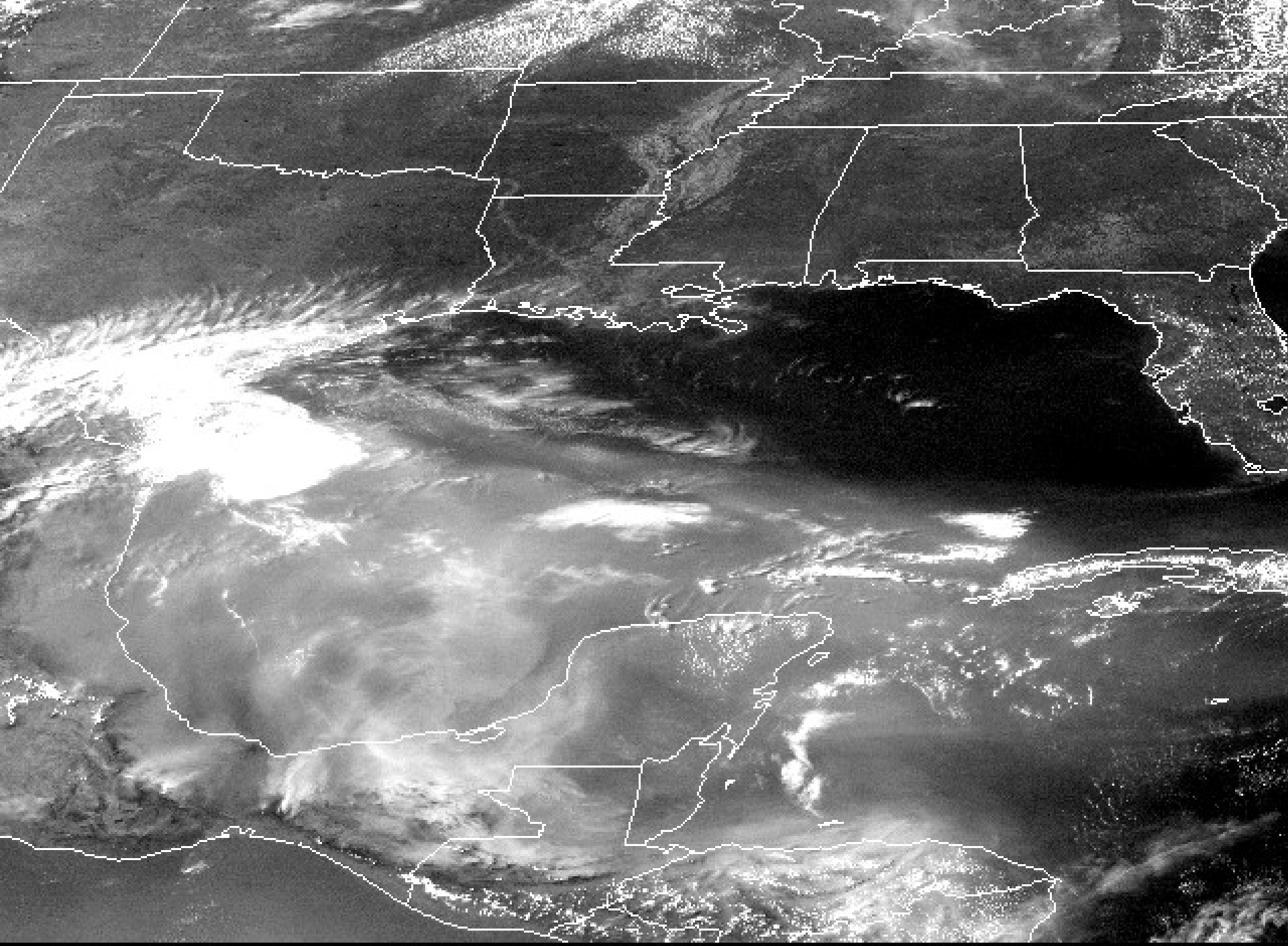


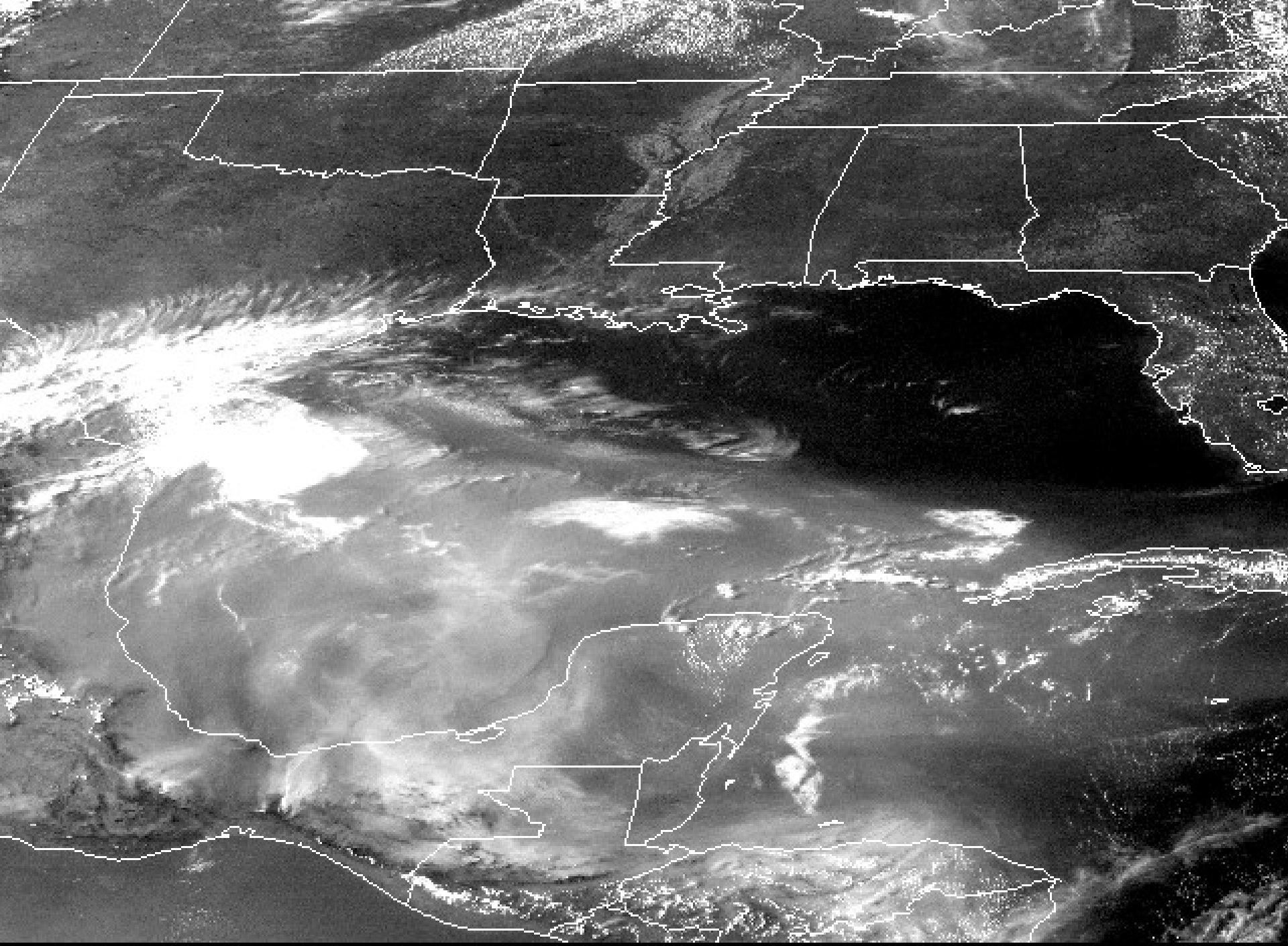


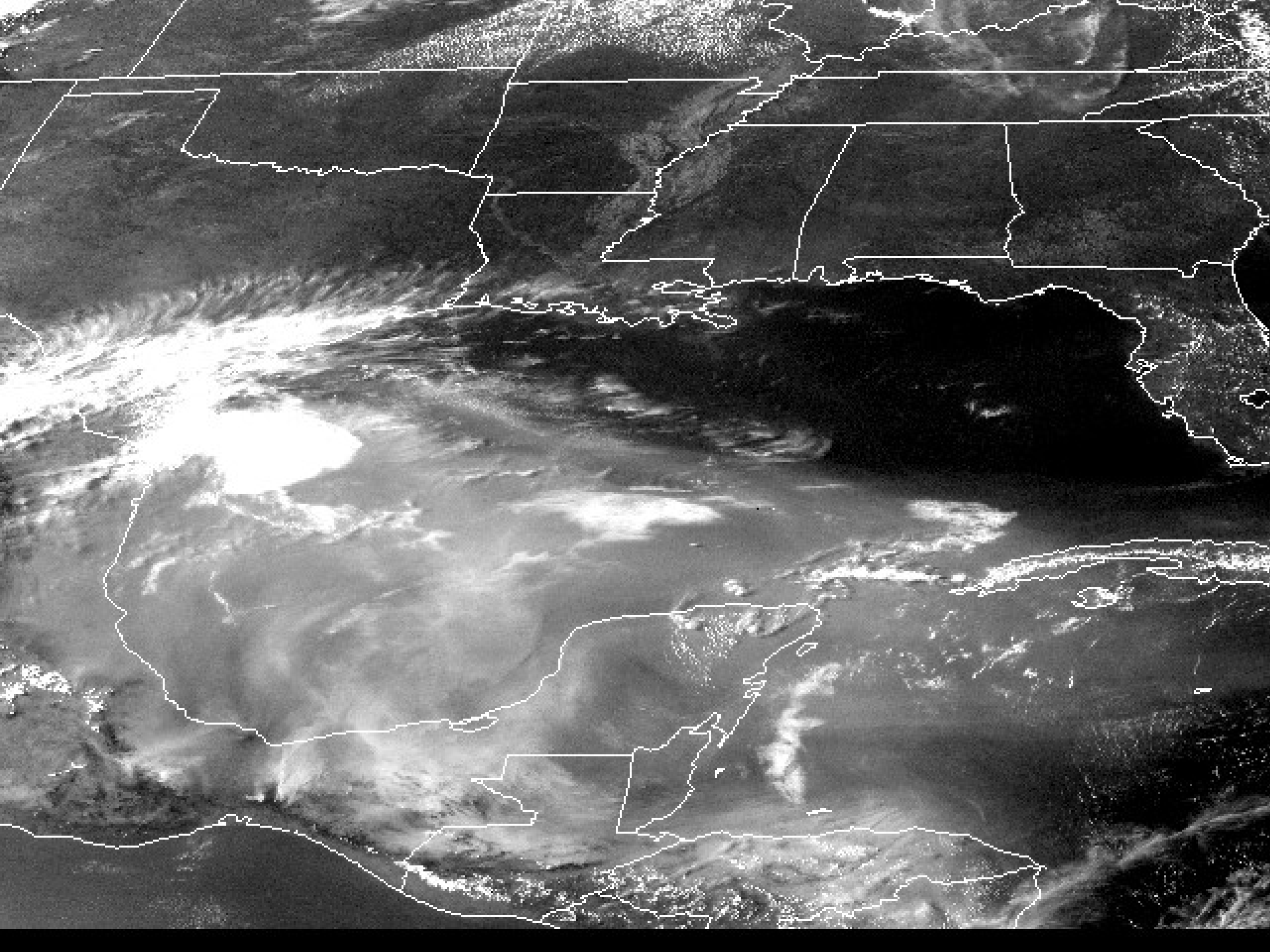












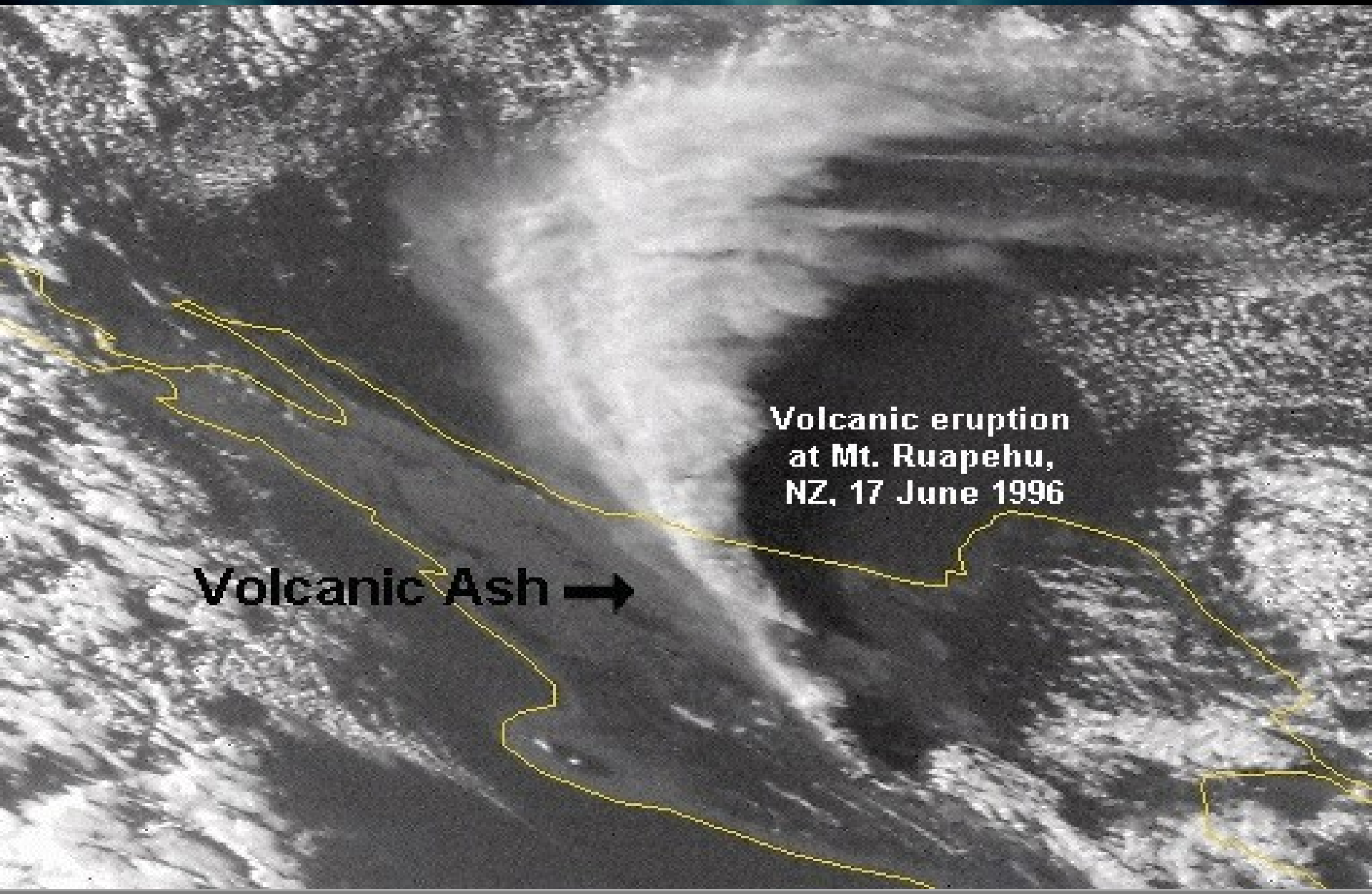
Cloud Identification

- Ash clouds at upper levels can be advected long distances by the wind flow.

- The upstream edge is normally thick, while downstream; the ash cloud is more diffuse and thick.
- If thick, it will look the same as thick cirrus on VIS and IR imagery.

18MAY80 4:15PM PDT-ERUPTION + 7HRS 36MIN
NOAA
Ash Clouds

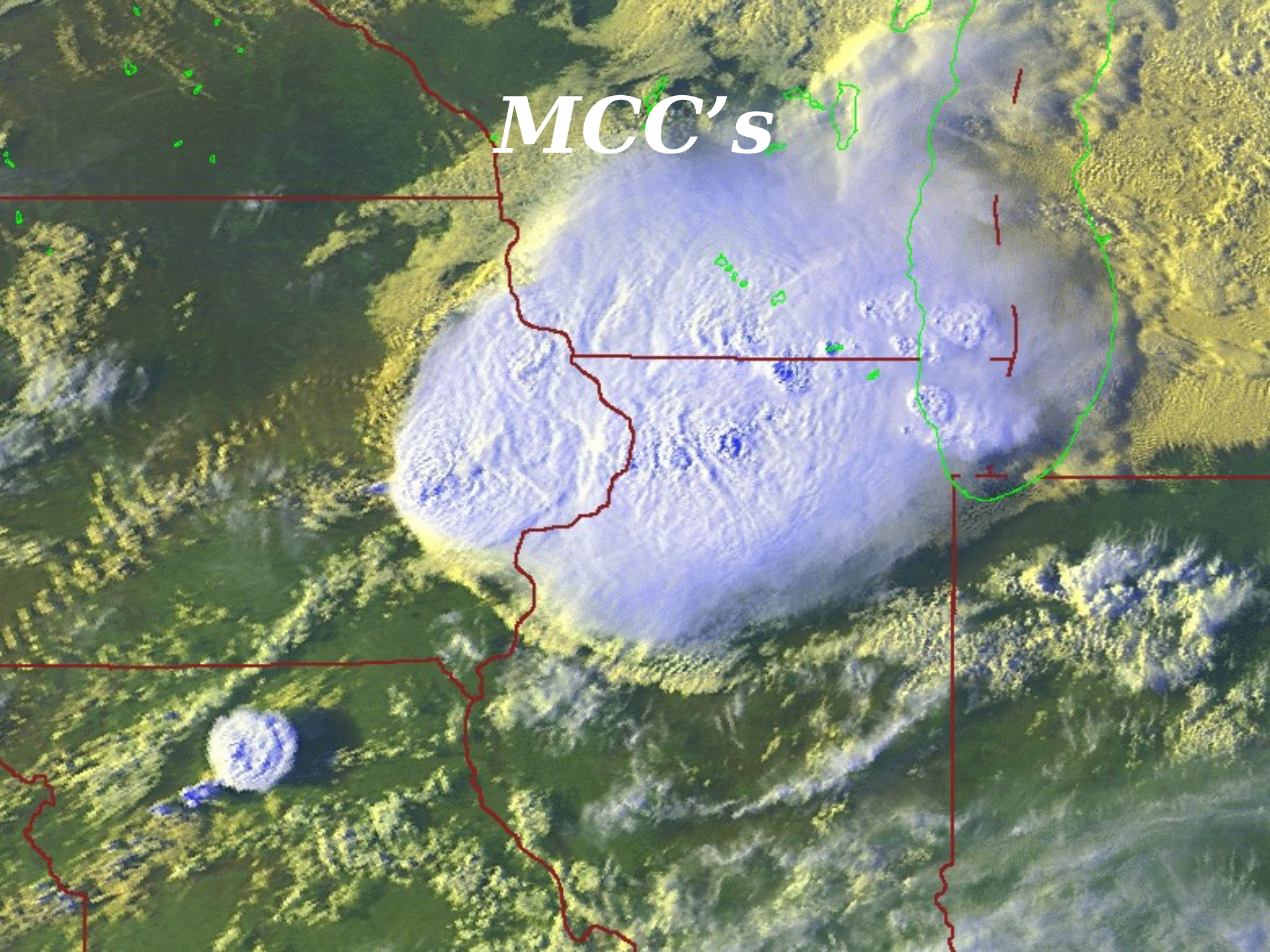
Volcanoes

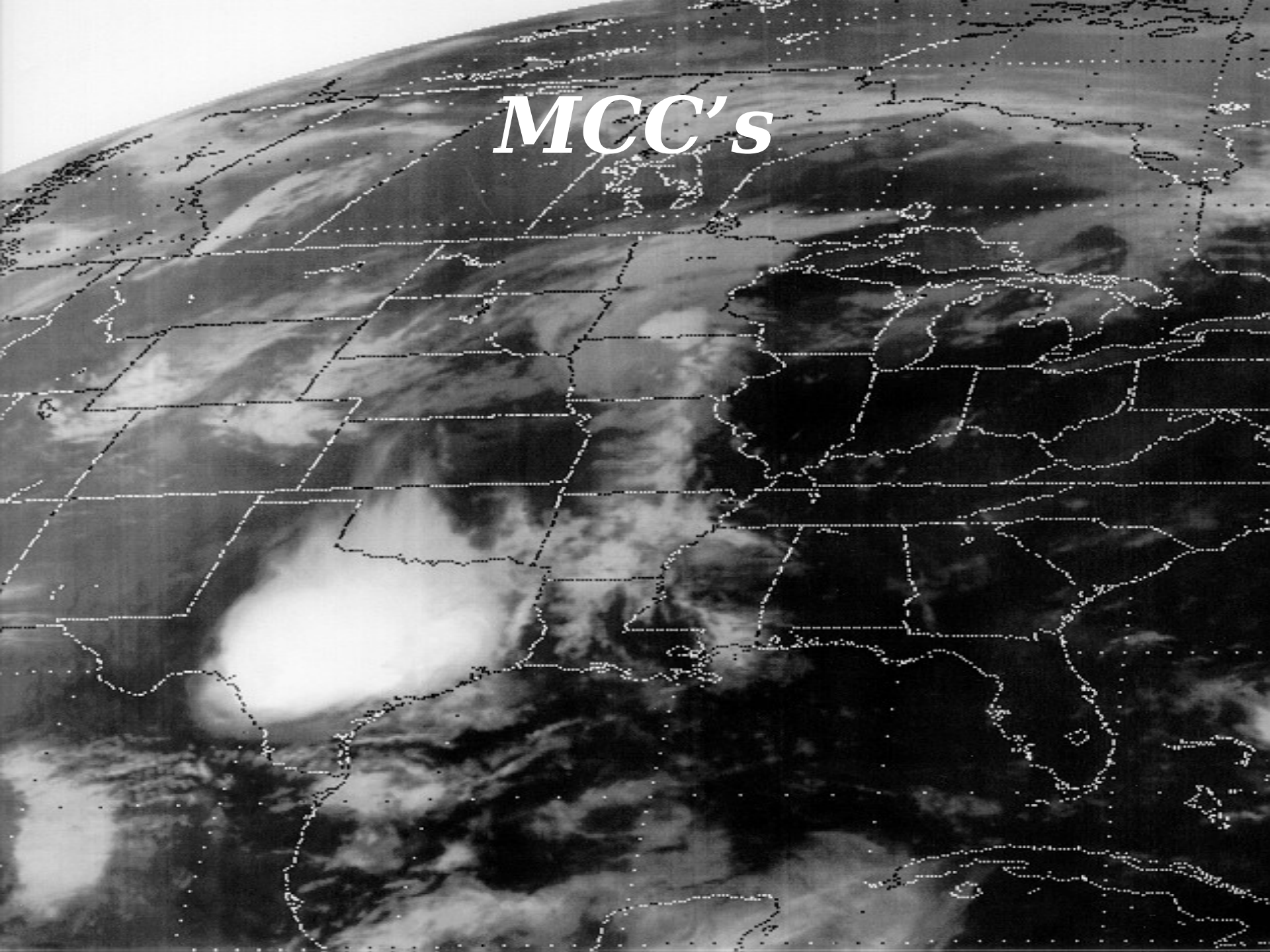


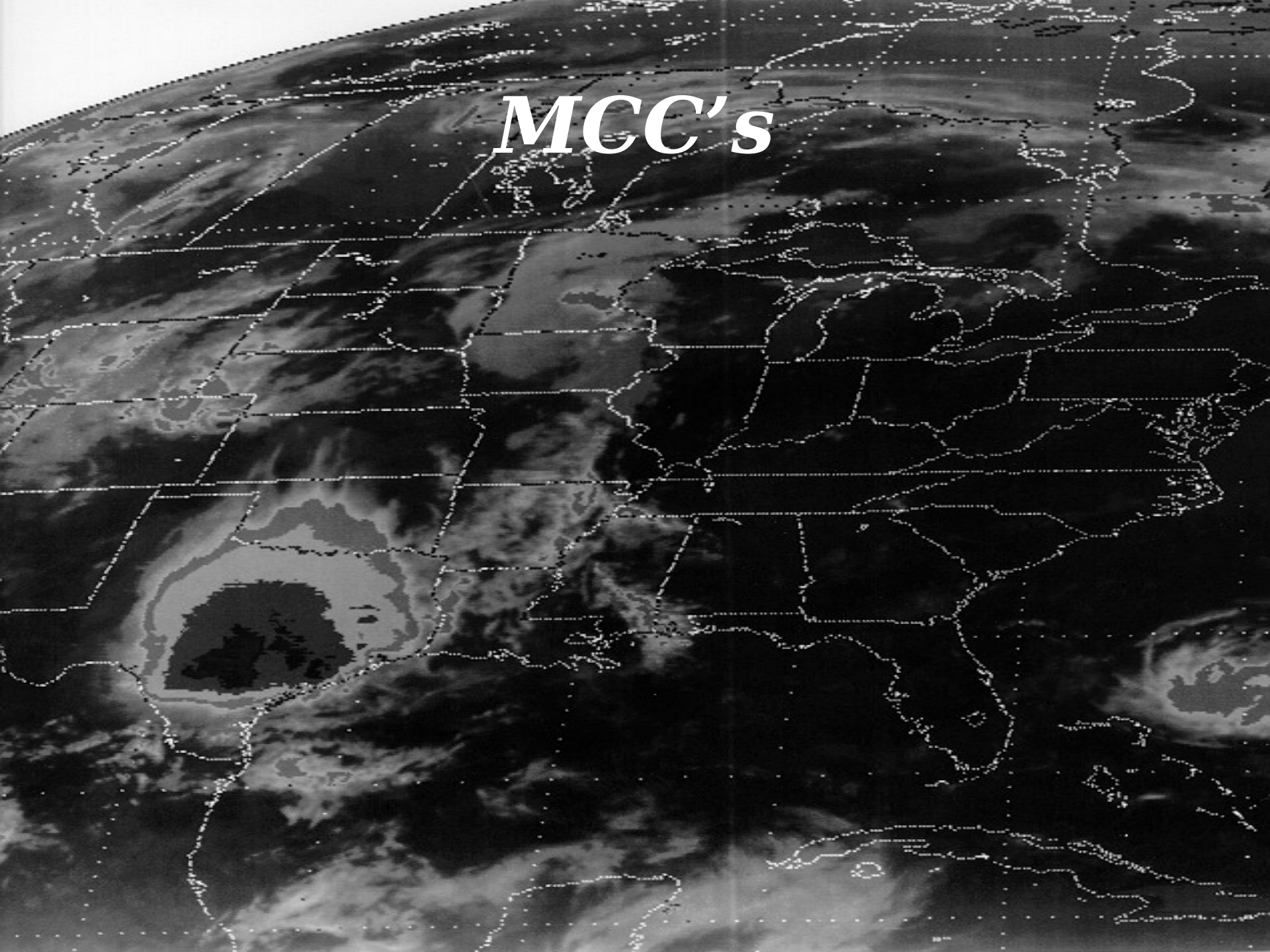
Determine cloud features on February 20

Cloud Identification

- Mesoscale Cloud Organizations
  - Mesoscale convective complexes (MCC)
    - MCC is a large, almost circular area of organized cumulonimbus clouds
    - MCC is not associated with fronts; persist for greater than six hours

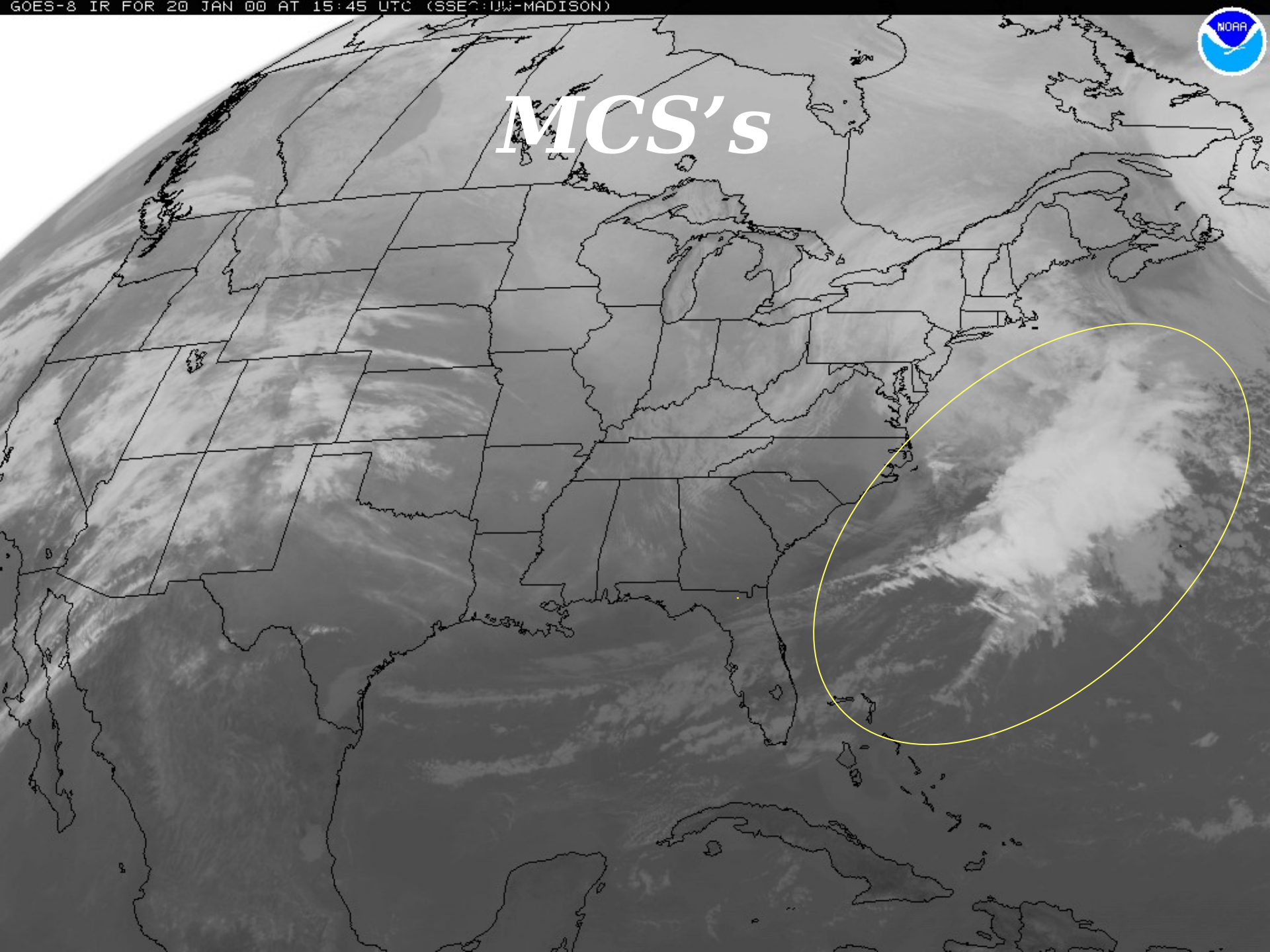

MCC's

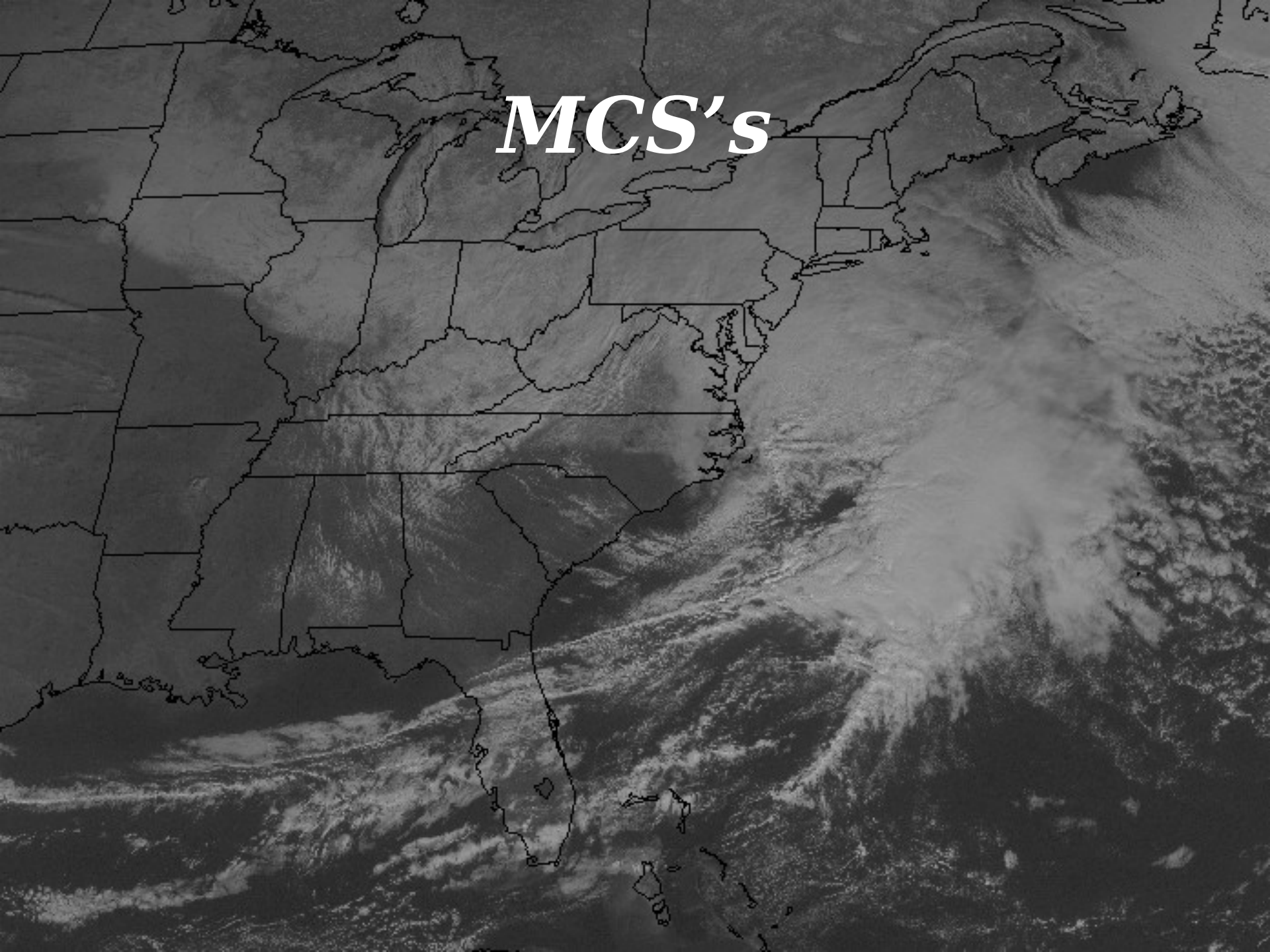

MCC's

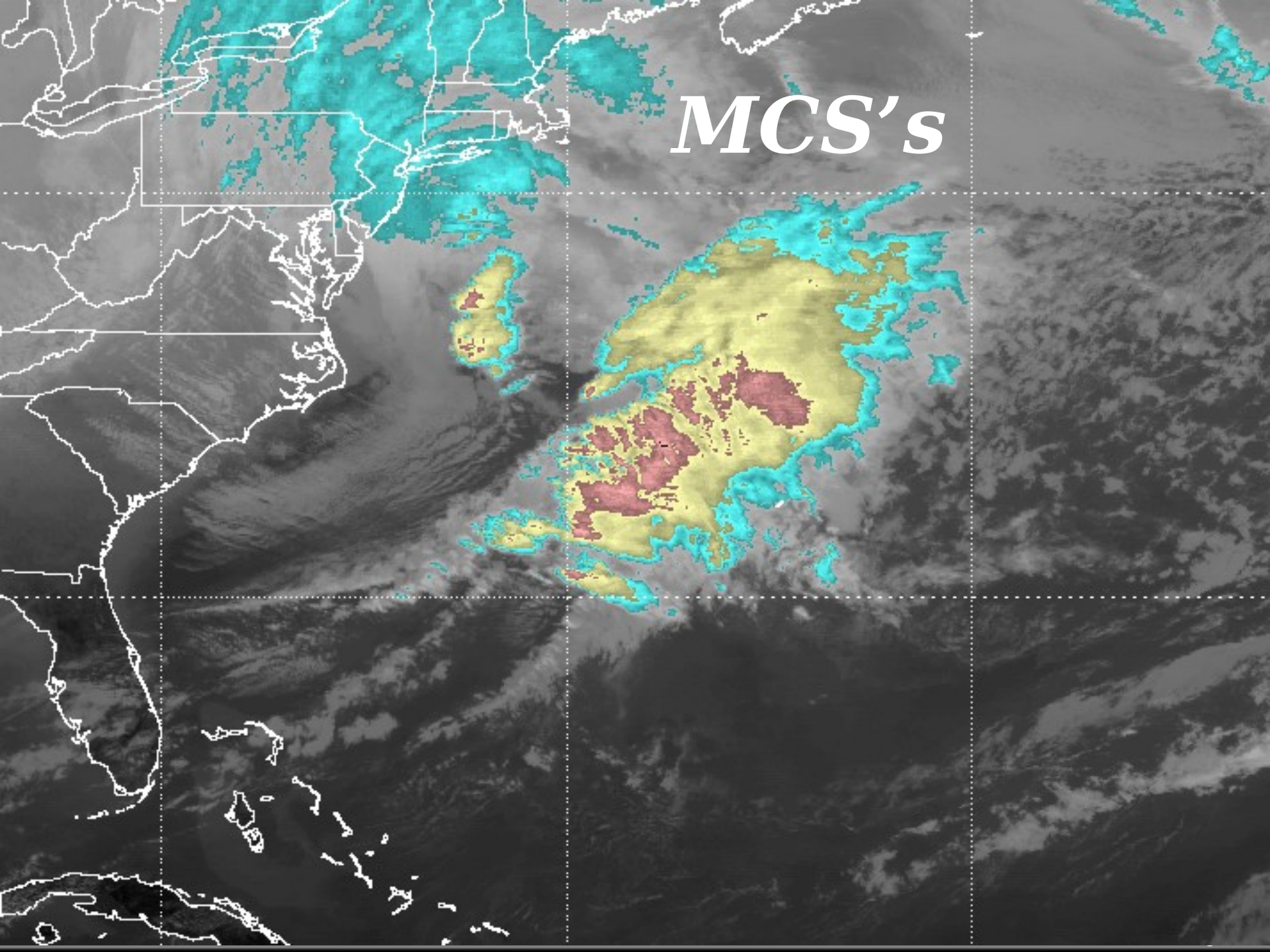

MCC's

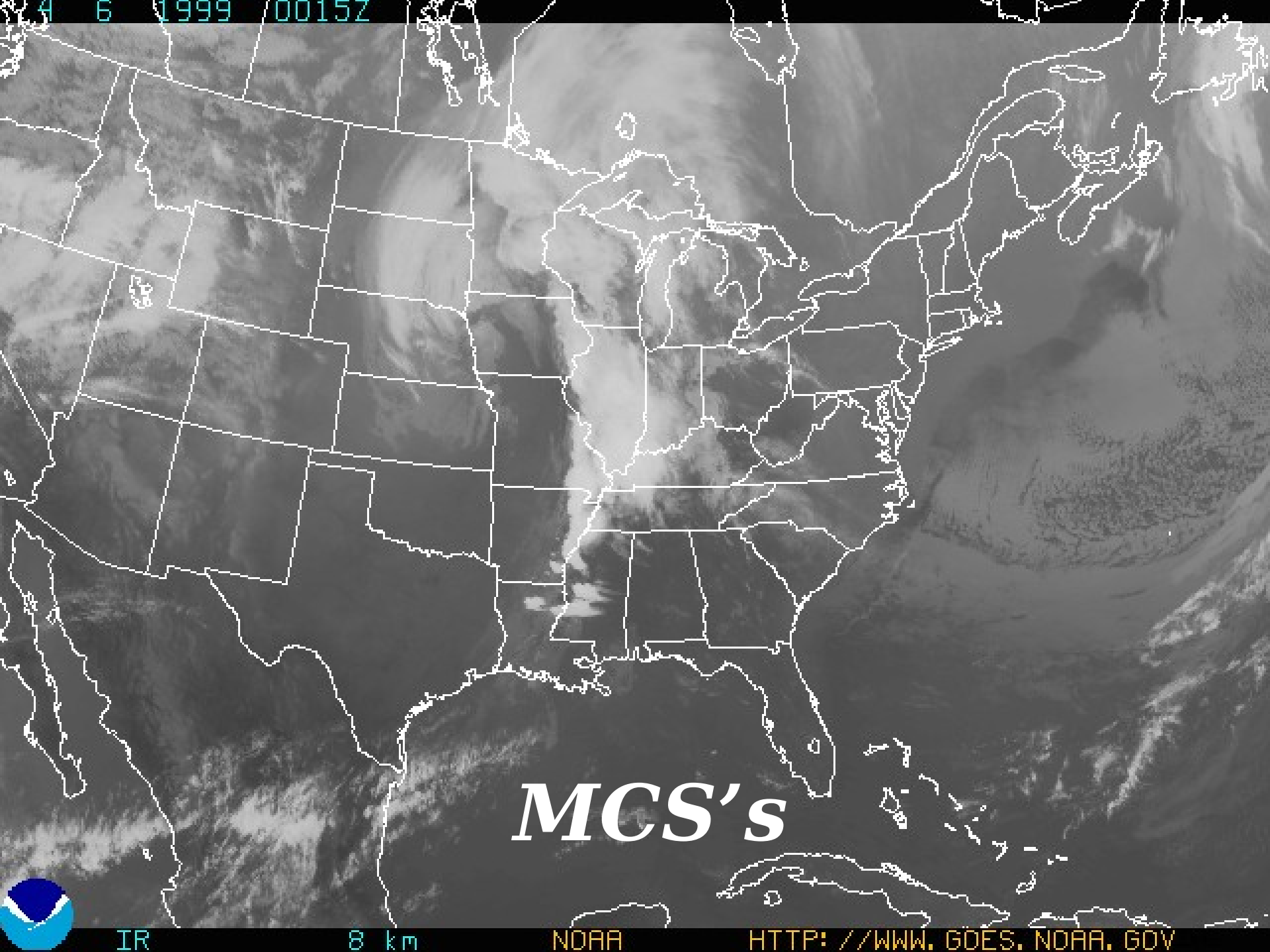
Cloud Identification

- Mesoscale convective system (MCS)
  - MCS is a large, elongated noncircular area of organized cumulonimbus clouds
  - MCS is normally associated with fronts
  - Typically forms a “wedge” cloud formation due to interaction between the Polar Front Jet (PFJ) and Subtropical Jet (STJ)


GOES-8 IR FOR 20 JAN 00 AT 15:45 UTC (SSEC:UW-MADISON)
NOAA
MCS's


MCS's

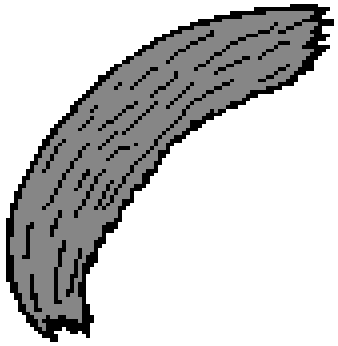

MCS's


4 6 1999 /0015Z
MCS's
IR 8 km NOAA HTTP://WWW.GOES.NOAA.GOV

Cloud Identification

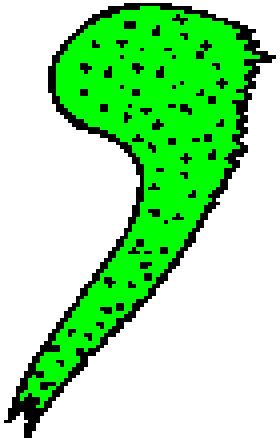
- Synoptic-scale cloud organizations
  - Baroclinic zone cloud system
    - This is a large, extensive area of multi-layered clouds, which are associated with a baroclinic zone (frontal zone)
    - The multi-layered clouds are usually topped by a large cirrostratus shield
    - The cloud shield forms in an area where the temperature field is out-of-phase with the pressure/wind field (a baroclinic condition)

Synoptic Scale Cloud Organization



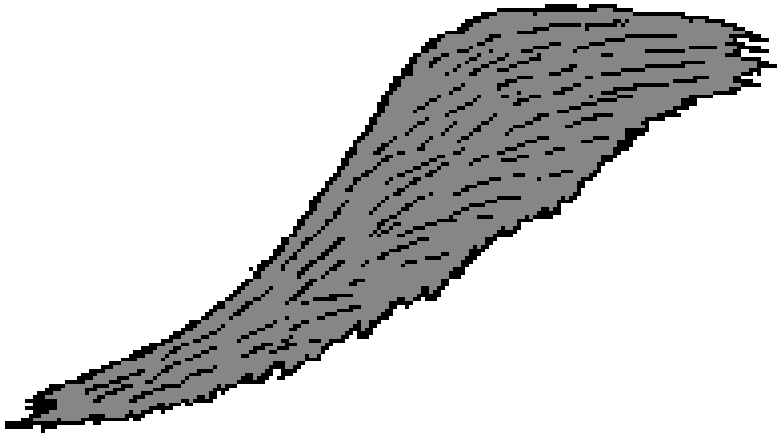
Deformation Zone

Cloud System



Vorticity Comma

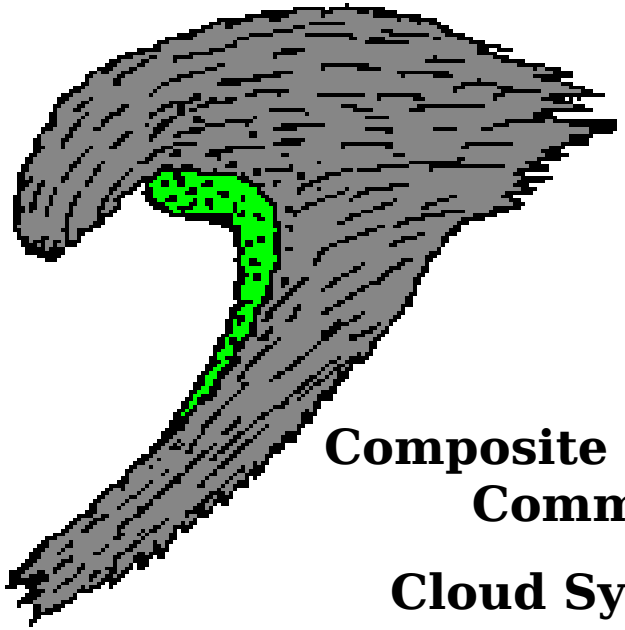
Cloud System



Baroclinic Zone

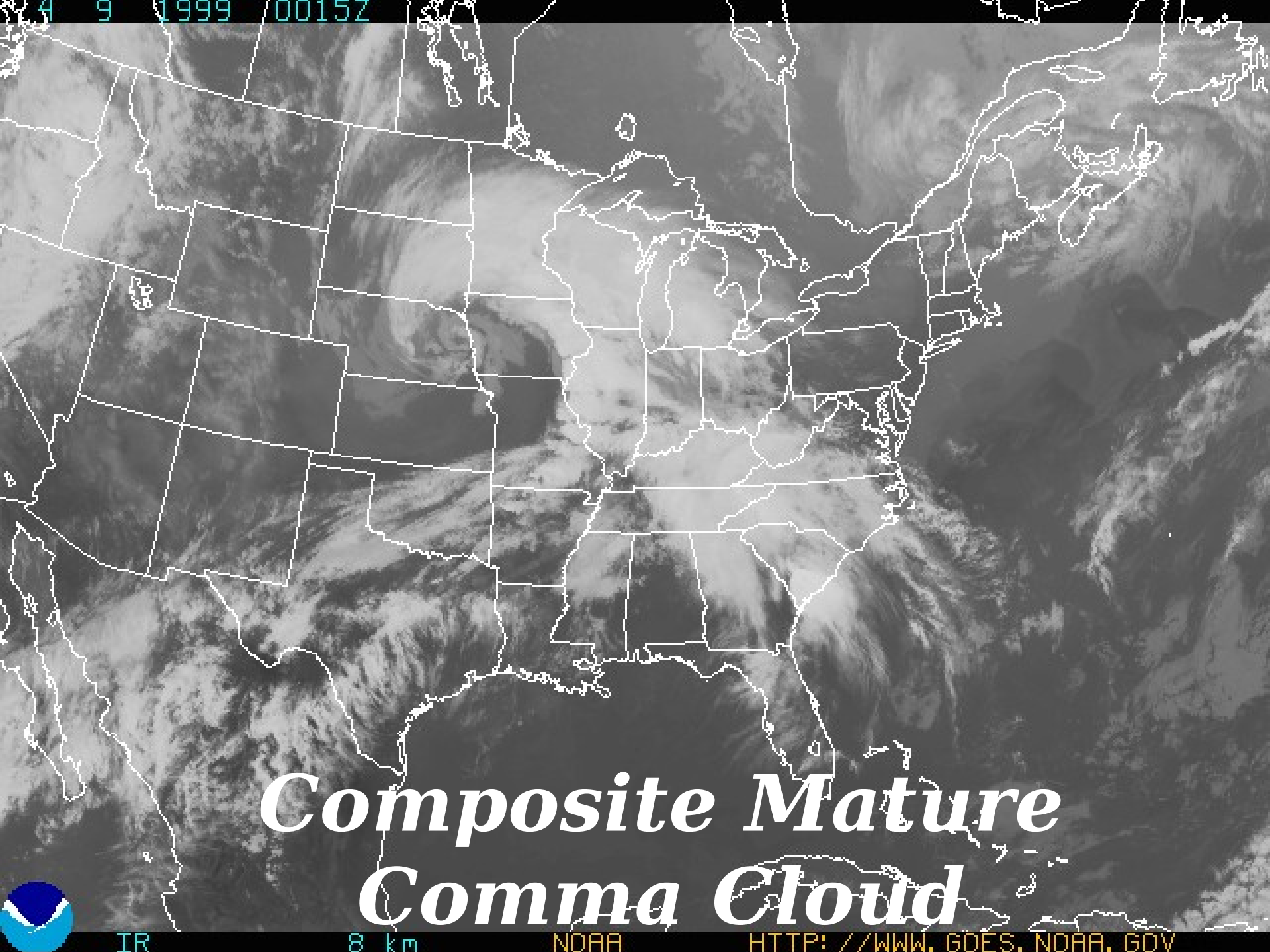
Cloud System

Composite Mature Comma Cloud



Composite Mature Comma

Cloud System


4 9 1999 0015Z
Composite Mature
Comma Cloud
IR 8 km NOAA HTTP://WWW.GOES.NOAA.GOV

Cloud Identification

- The upward vertical motion in this region is caused by the forward or rearward sloping ascent of the warm conveyor belt.
- Precipitation falling from this cloud shield is usually of a steady, stratiform nature.
- Areas of convection can be embedded within the stratiform precipitation shield.

Cloud Identification

- Vorticity comma cloud system
  - This is an area of low or middle-level convective clouds organized into a comma shape
  - If the atmosphere is unstable enough to support strong convection, the comma can also be composed of the cirrus anvils of cumulonimbus clouds
  - This cloud system is caused by the upward vertical motion resulting from divergence ahead of a vorticity maximum
  - Precipitation is convective with rain showers/snow showers

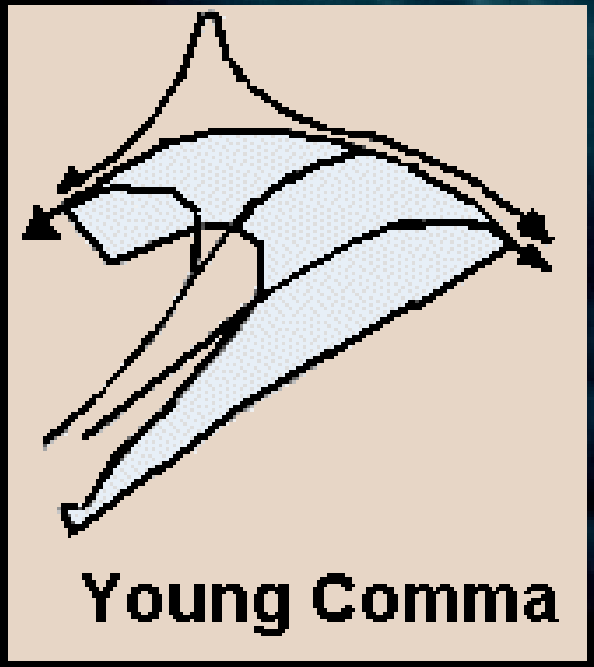
Cloud Identification

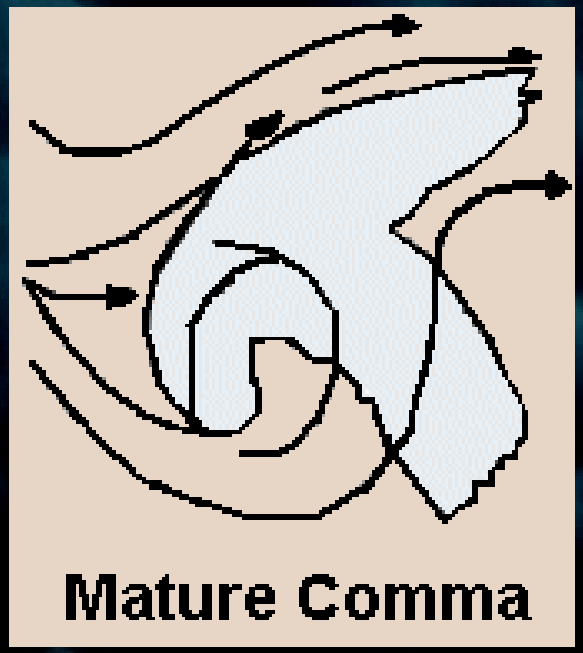
- Deformation zone cloud system
  - This is an elongated area of multi-layered clouds being "stretched" and "sheared" by an upper-level deformation zone
  - The multi-layered clouds are usually topped by a cirrostratus shield
  - The cloud masses elongate along the axis of dilatation and shrinks along the axis of contraction
  - The upward vertical motion causing the clouds is usually due to divergence aloft associated with a vorticity maximum

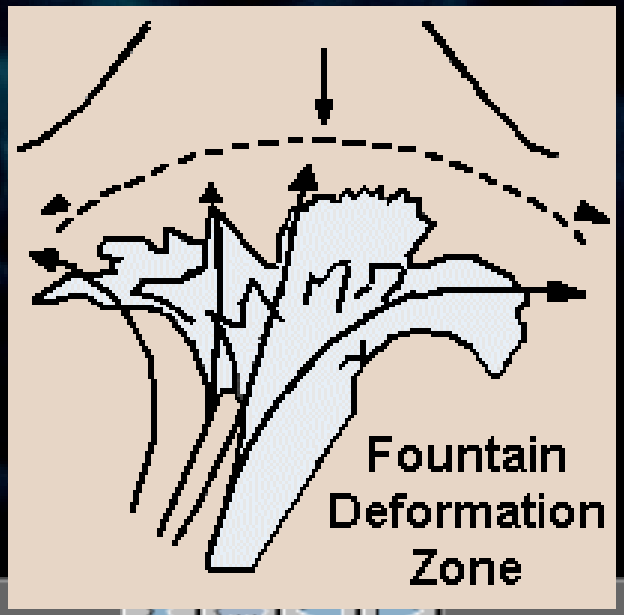
Cloud Identification

- The upper-level wind field "rearranges" the cloud mass into the classic deformation pattern.
- Precipitation is normally stratiform.
- Precipitation is heaviest in the southern portion of the deformation zone cloud system, where the influences of the WACB, CACB, and DIV ahead of the short-wave trough result in an area of moist air undergoing UVM.

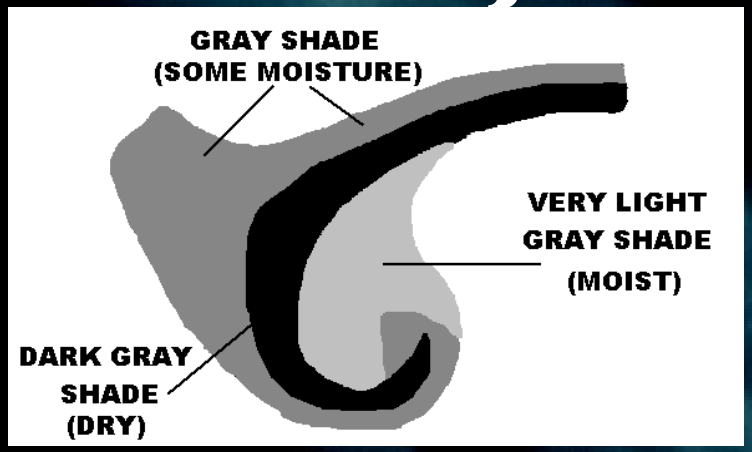
Upper-level Deformation Zone

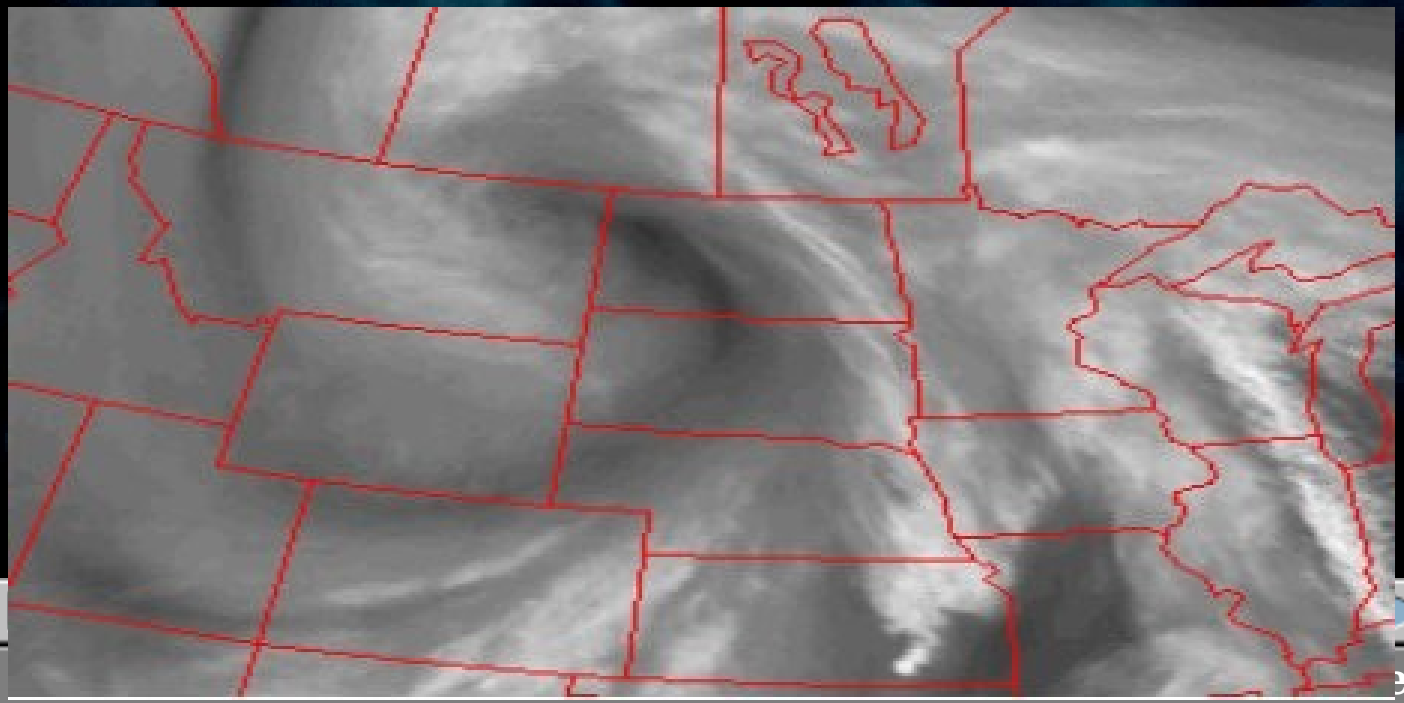






Water Vapor and Deformation Zone

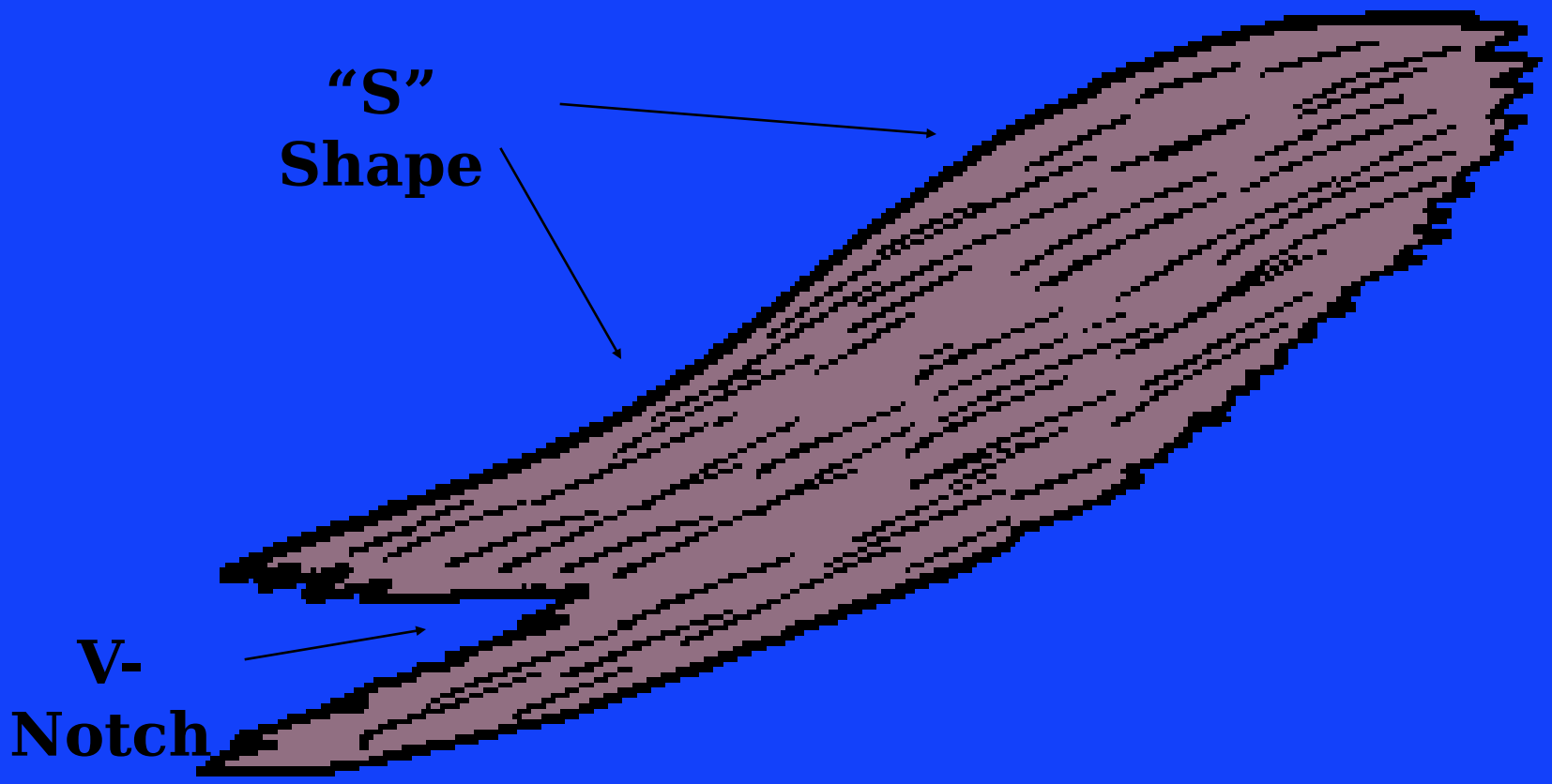




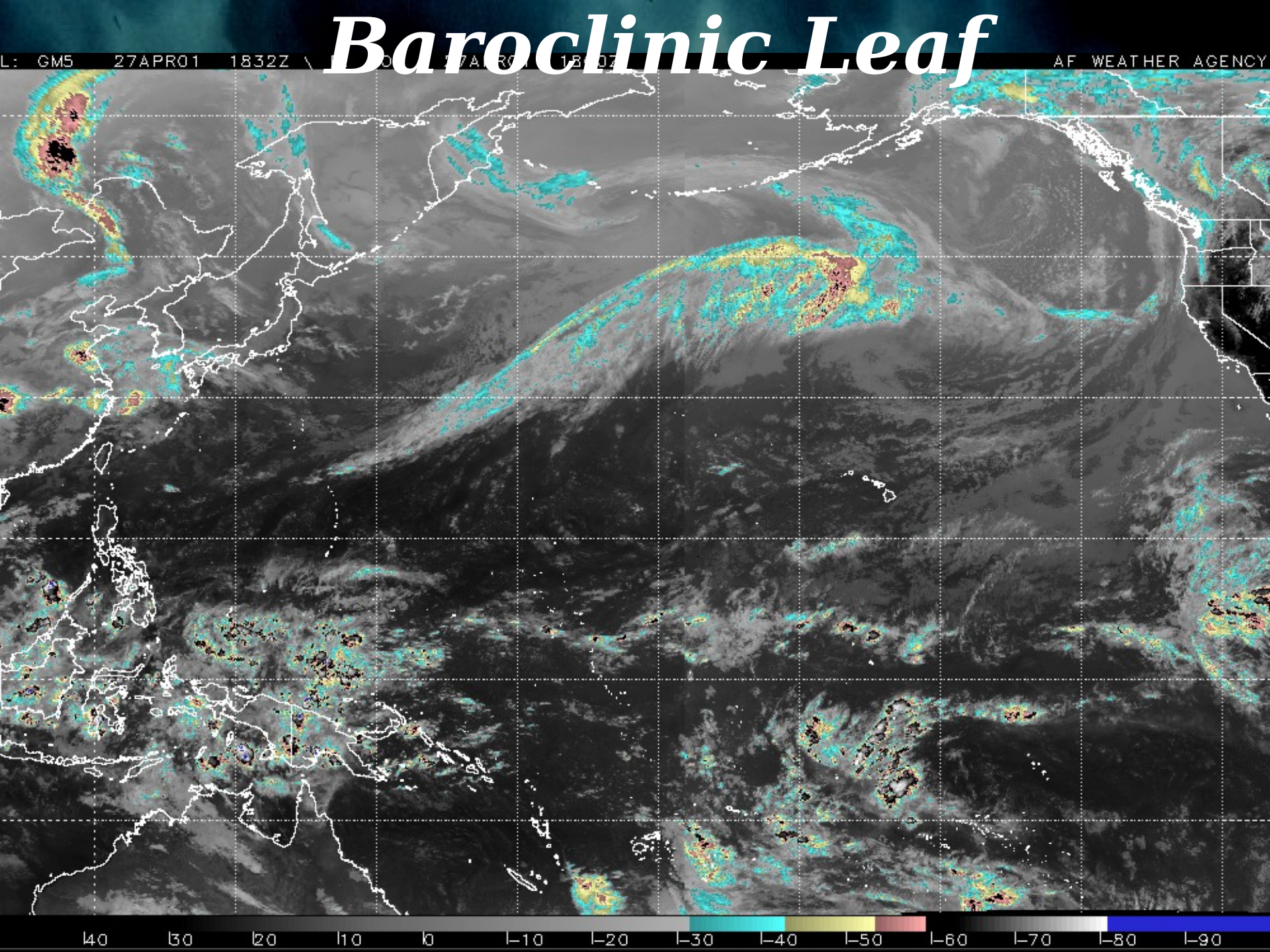
Cloud Identification

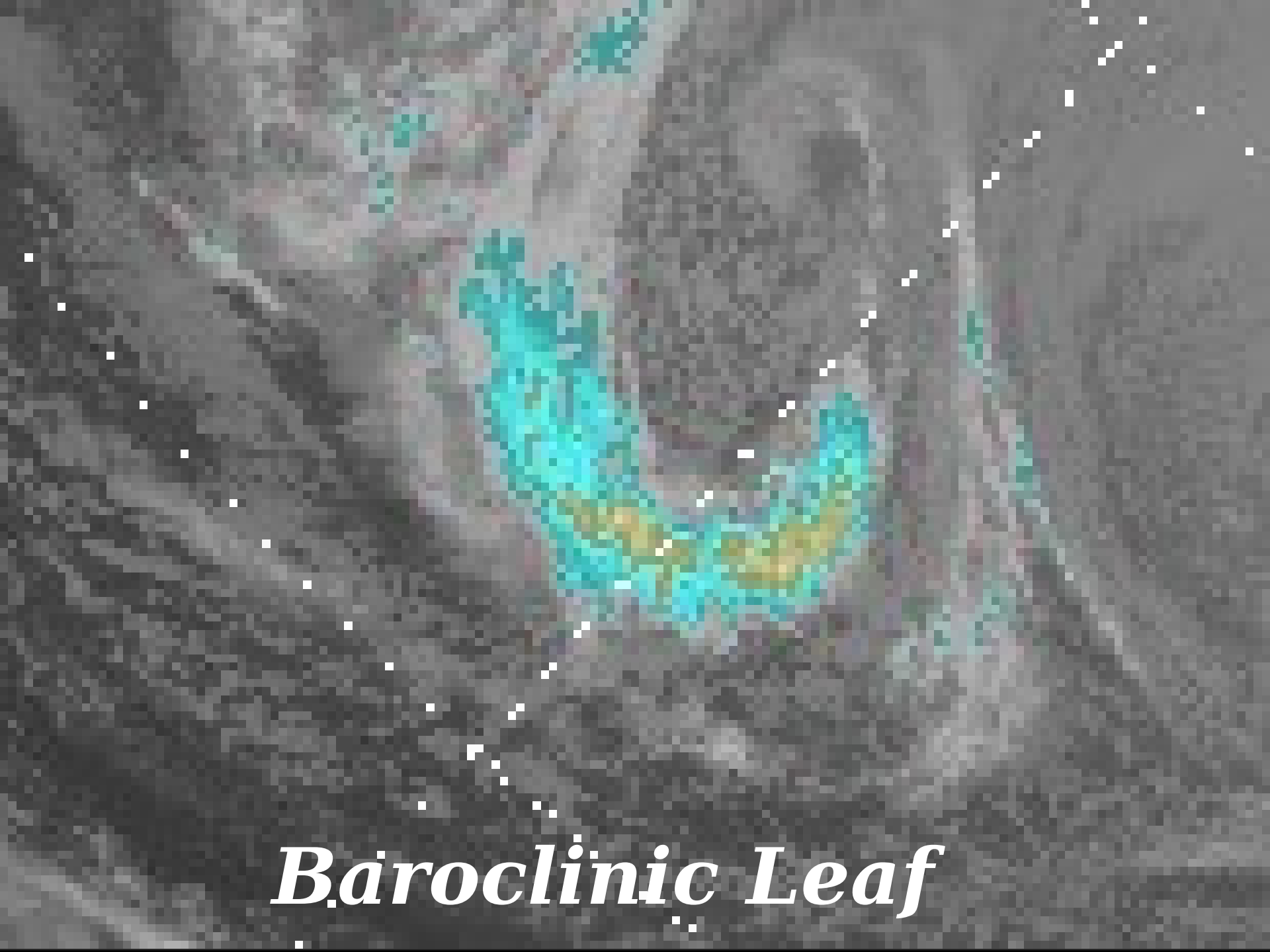
- Baroclinic Leaf
  - The baroclinic leaf is a mid- and upper-level cloud pattern associated with a system which is just beginning to develop
  - "S" shape on the sharp upstream edge of the cloud system
  - "V" notch in the tail of the leaf. Seen in straight or cyclonic flow
  - Baroclinic leaves are smaller than the more developed synoptic systems
  - They also vary more in shape than the other cloud systems

BAROCLINIC LEAF



Baroclinic Leaf




Baroclinic Leaf

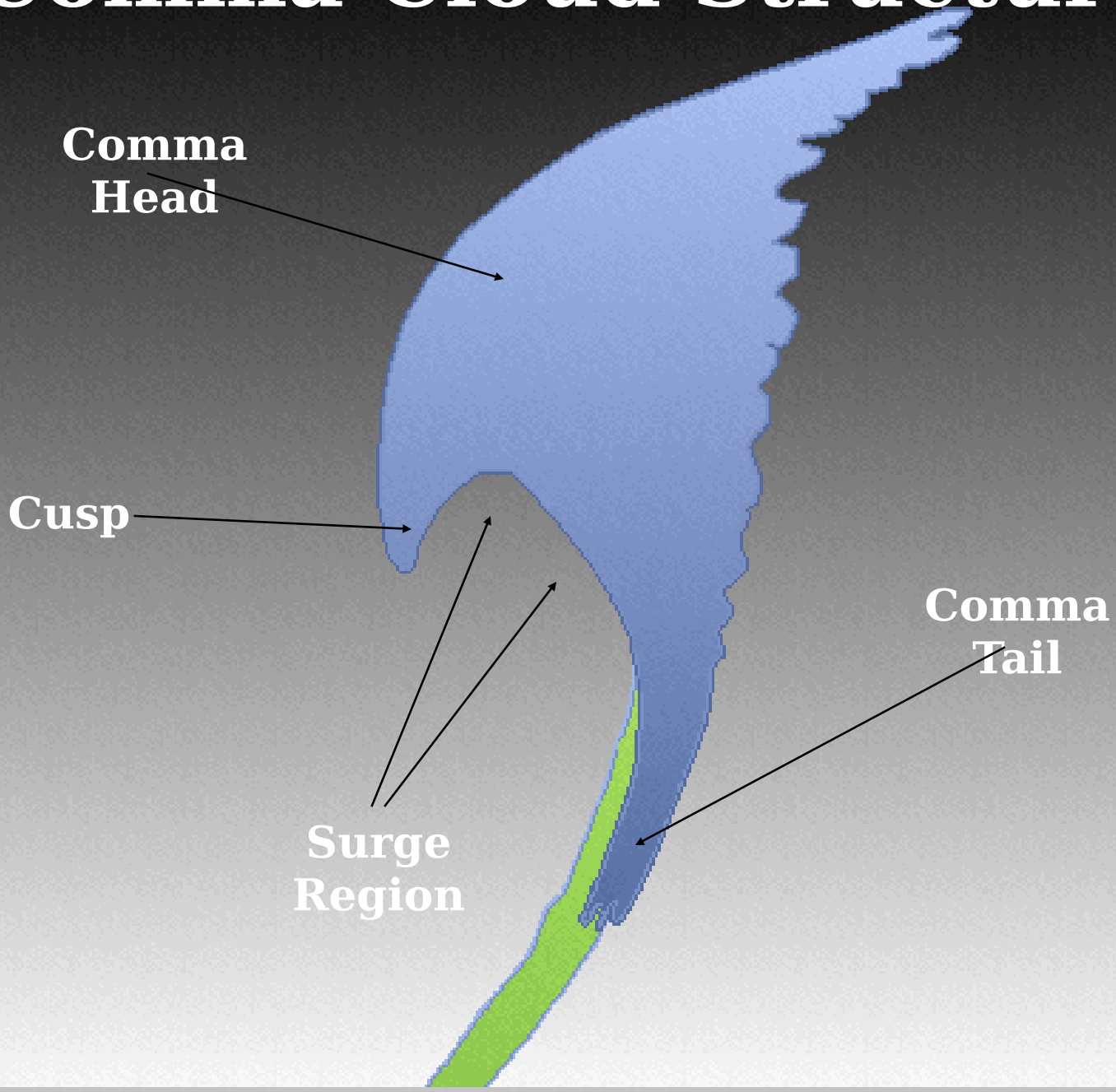
Cloud Identification

- Synoptic-scale comma clouds on satellite imagery
  - Baroclinic lows in the mid-latitudes are characterized by a large comma-shaped cloud mass
  - The comma cloud system is composed of the baroclinic zone, vorticity comma, and the deformation zone cloud systems discussed above

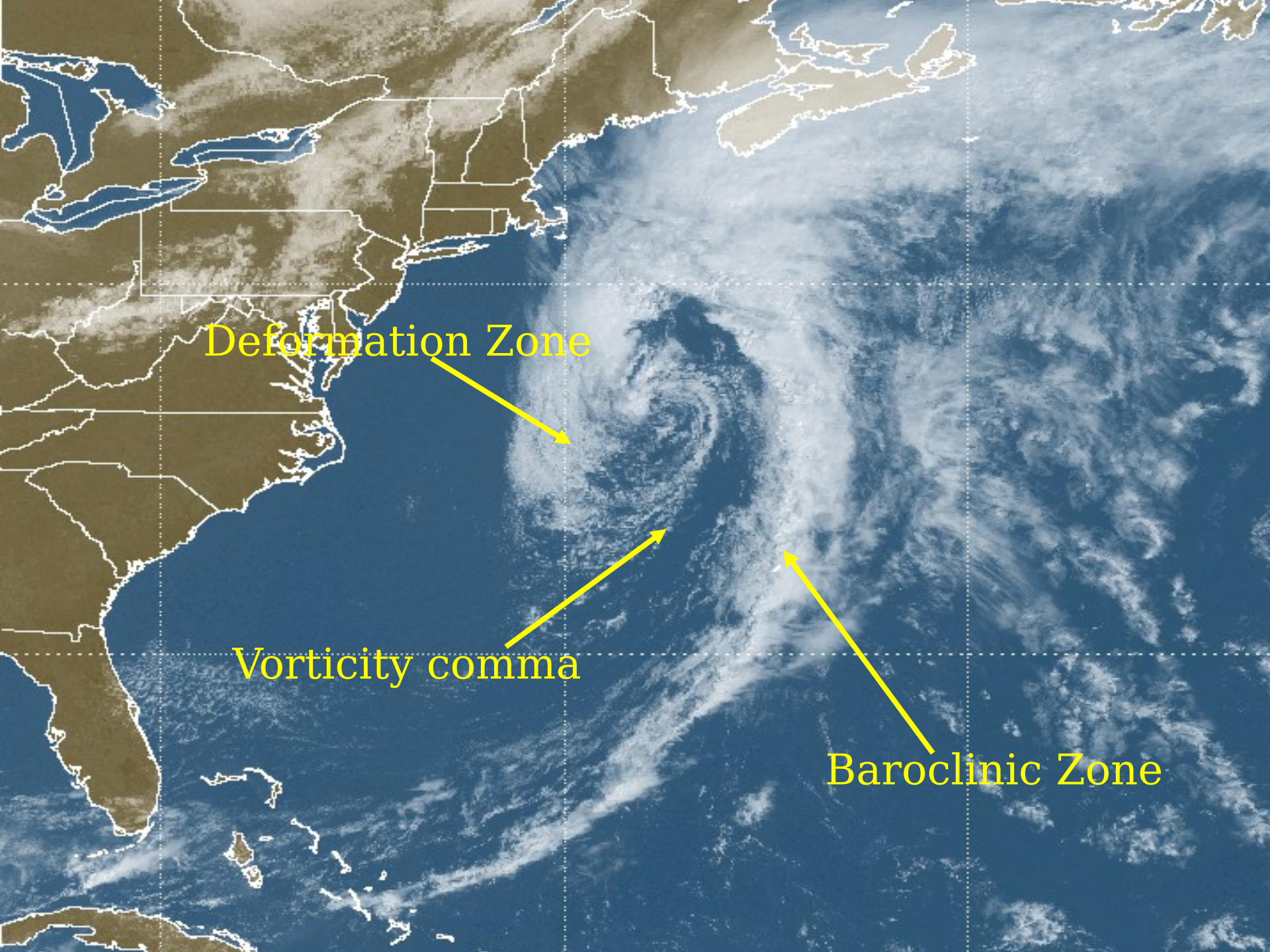
Cloud Identification

- Specific terminology is applied to certain portions of the synoptic scale comma cloud.
  - Surge region - the region where dry, subsiding air flows into the comma. (Also referred to as the dry slot).
  - Comma head - the northwest portion of the cloud system is composed of the deformation zone cloud system.
  - Comma tail - the long and relatively narrow band of clouds which extend southward from the main comma.
  - Cusp - the pointed region on the southern edge of the deformation zone cloud system. A well defined “cusp” may or may not be present with any given system.

Comma Cloud Structure

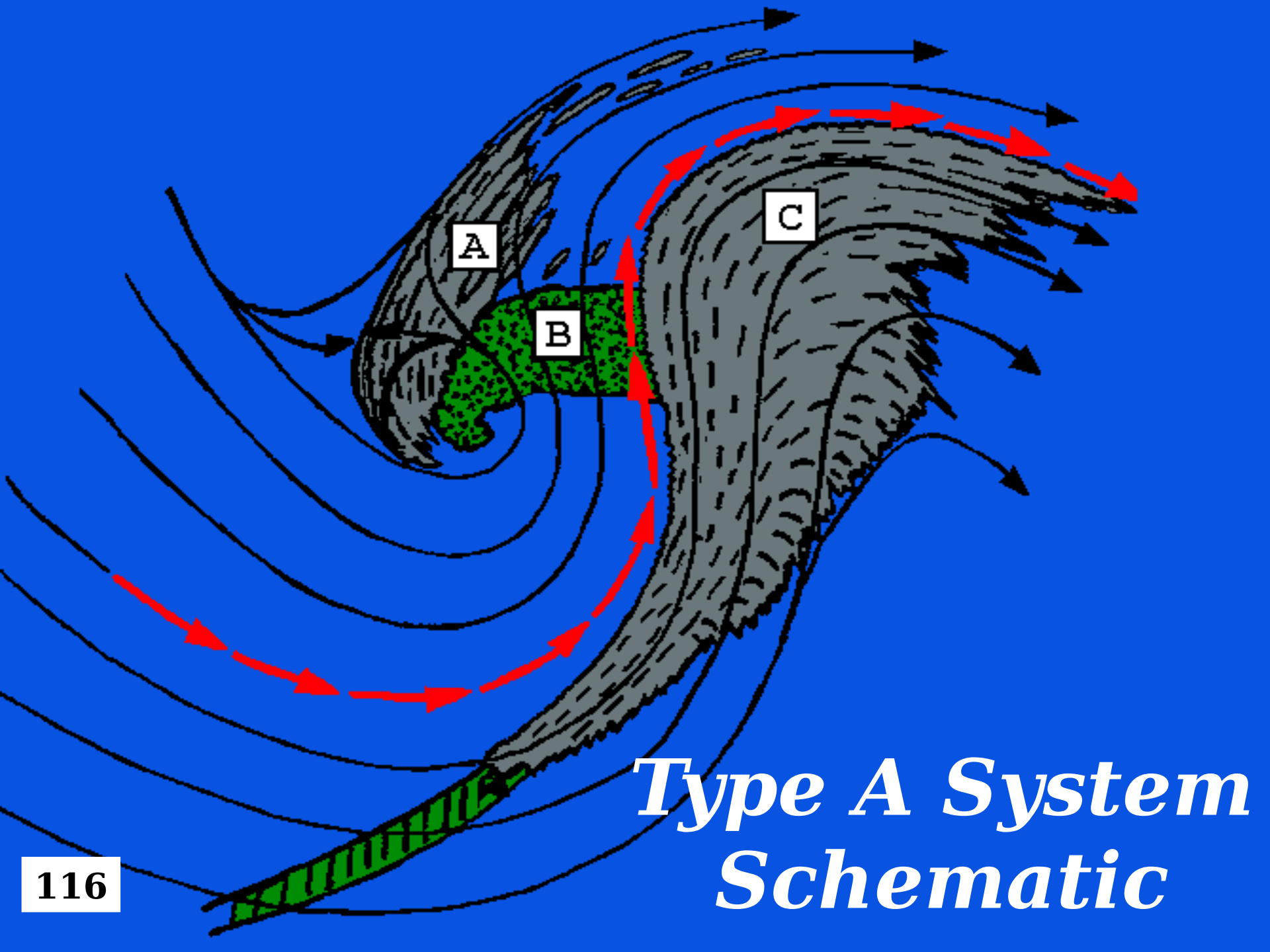


GOES-8 IR FOR 10 NOV 98 AT 20:45 UTC (SSEC:UW-MADISON)
NOAA
Comma Cloud Structure

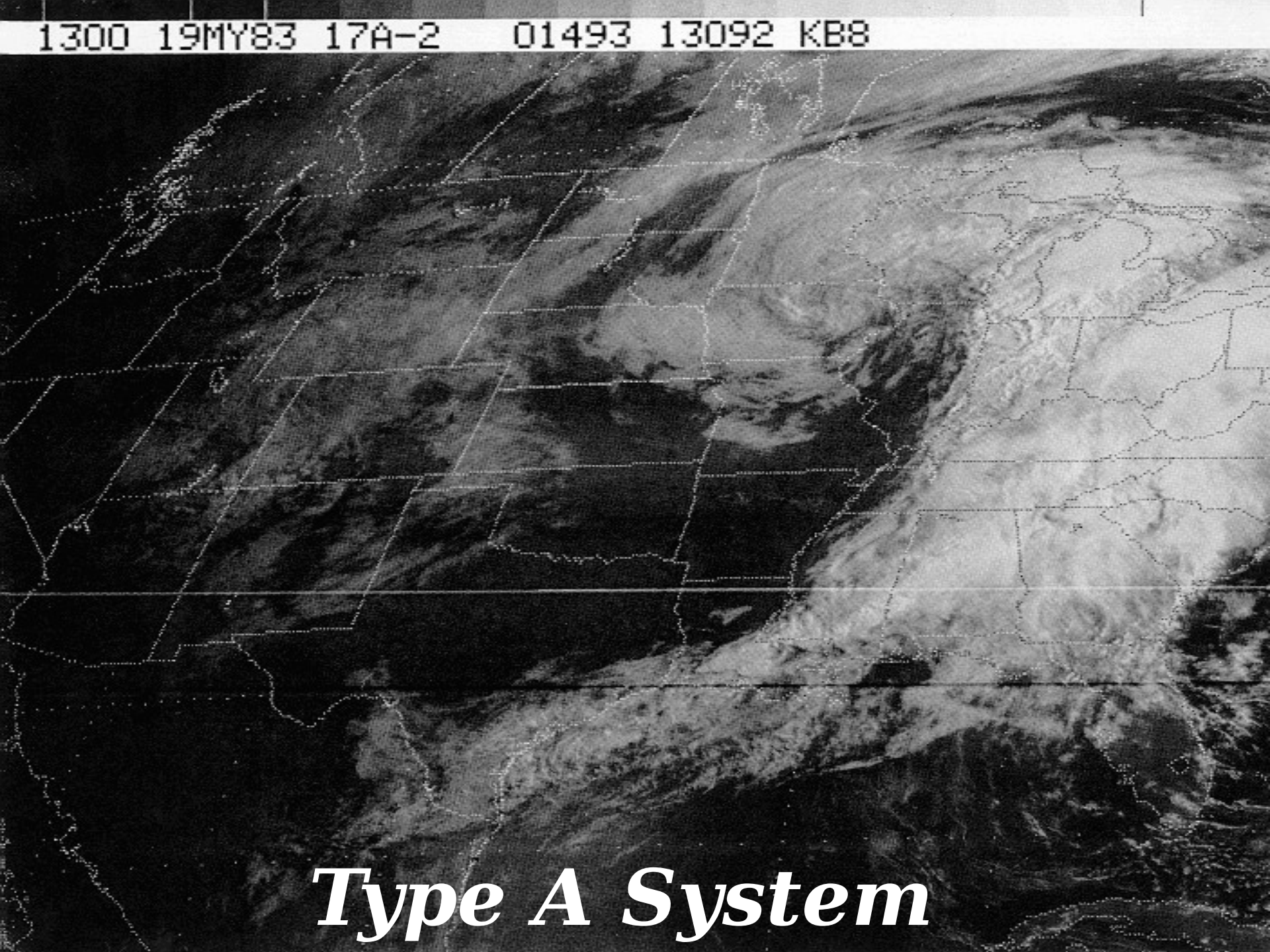

Deformation Zone
Vorticity comma
Baroclinic Zone

Cloud Identification

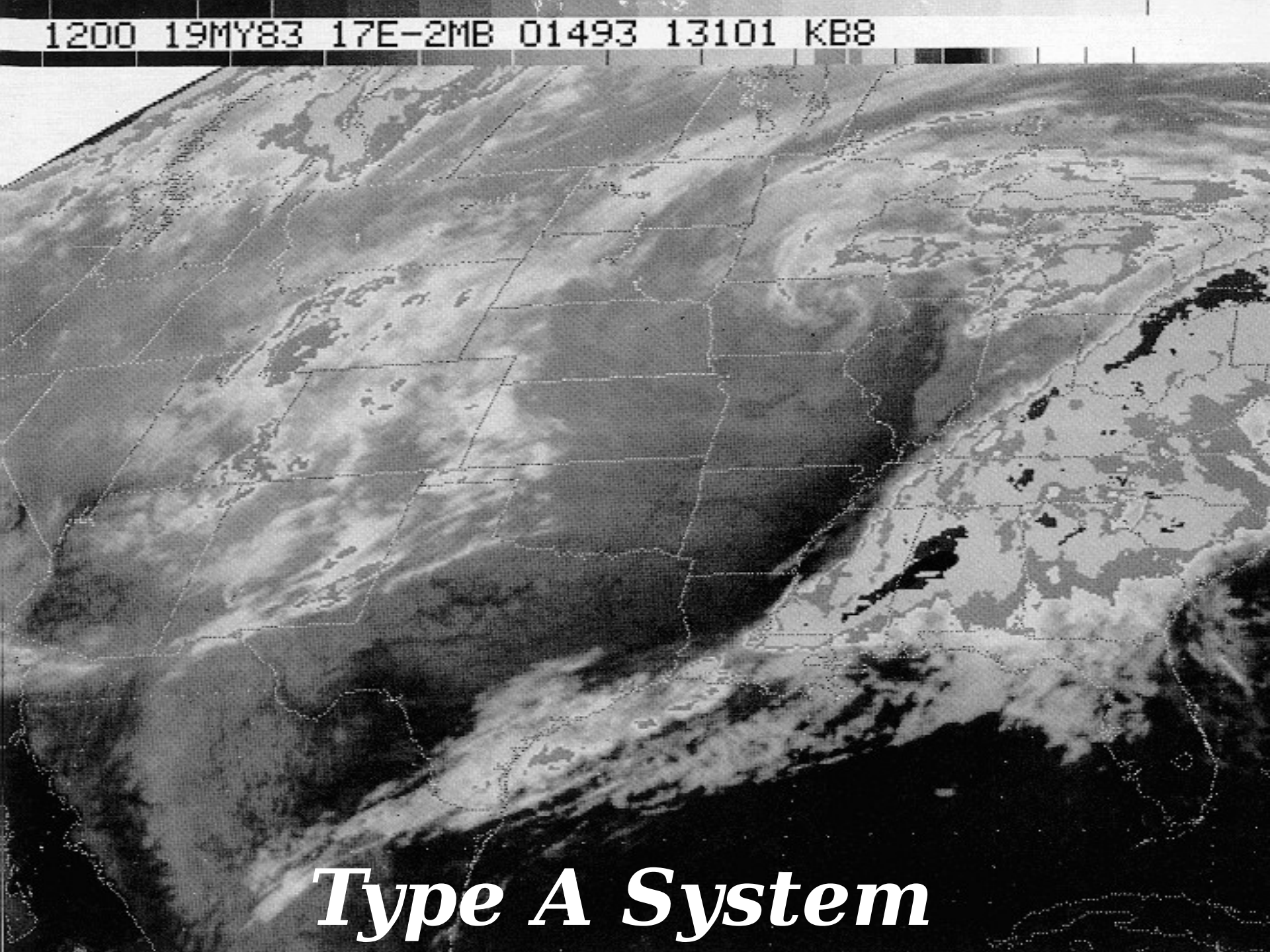
- Synoptic-scale comma cloud systems are divided into two types
  - Type A System
    - There is a distinct separation exists between the baroclinic zone cloud system and the def ormation zone cloud system
    - The deformation zone cloud system is lower and thinner than the baroclinic zone cloud system
    - It forms from meridianal trough cyclogenesis



Type A System Schematic



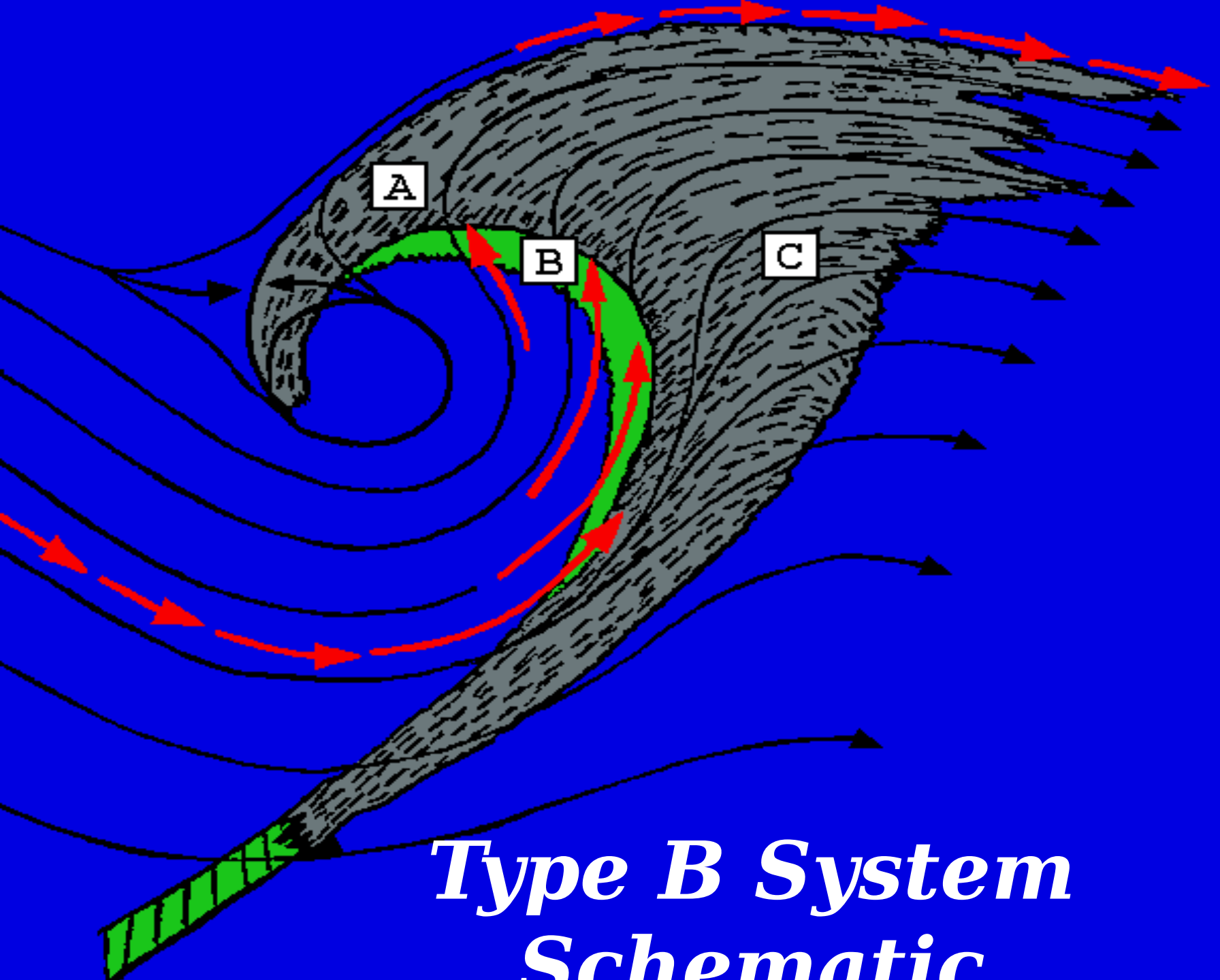
Type A System



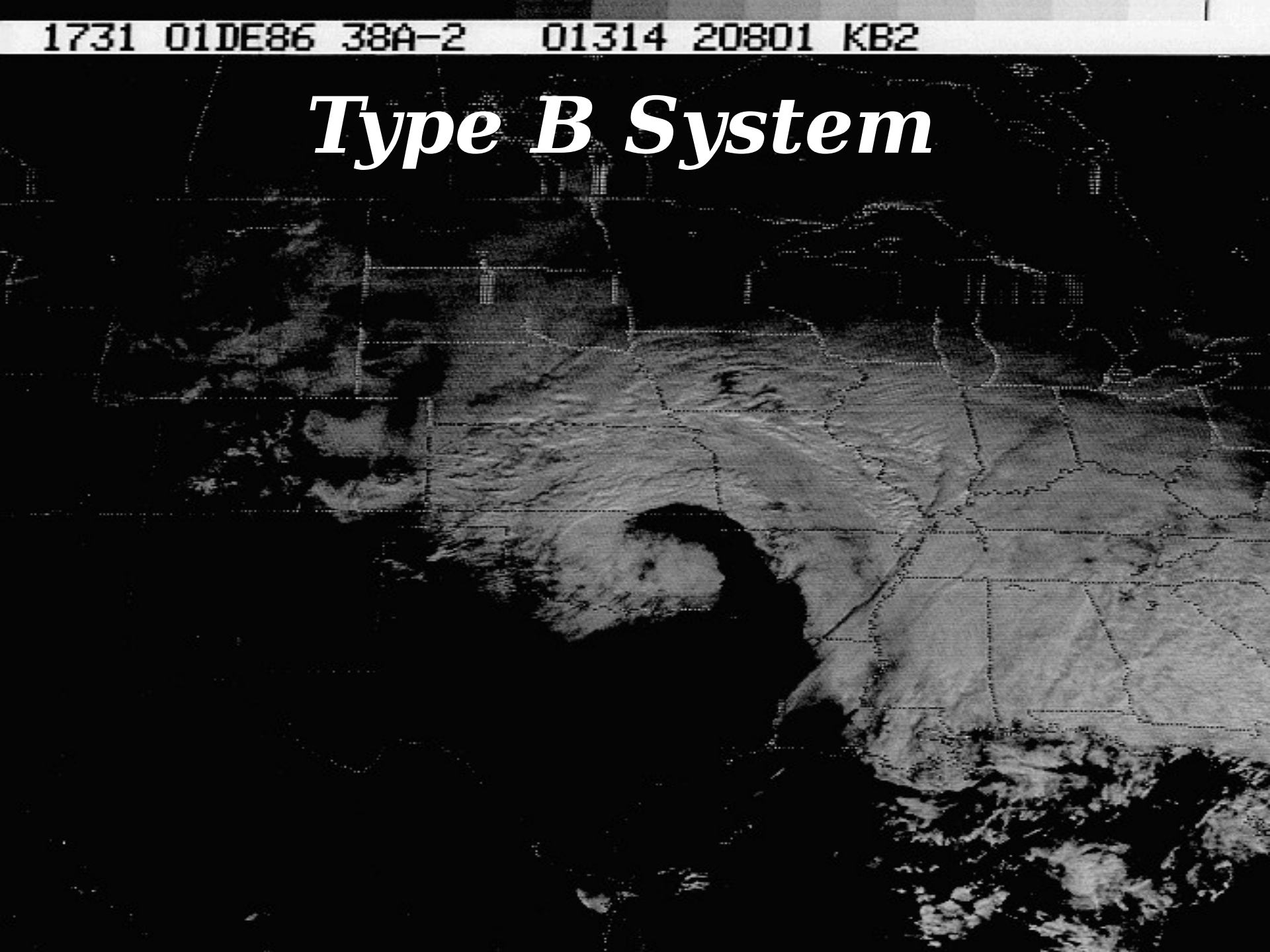
Type A System

Cloud Identification

- Type B System
  - The baroclinic and deformation zone cloud s ystems have merged together
  - The deformation zone cloud system is approximately the same height (temperature) as baroclinic zone cloud system
  - The deformation zone cloud system is also much thicker than that with a Type A system and formed from split flow cyclogenesis



Type B System Schematic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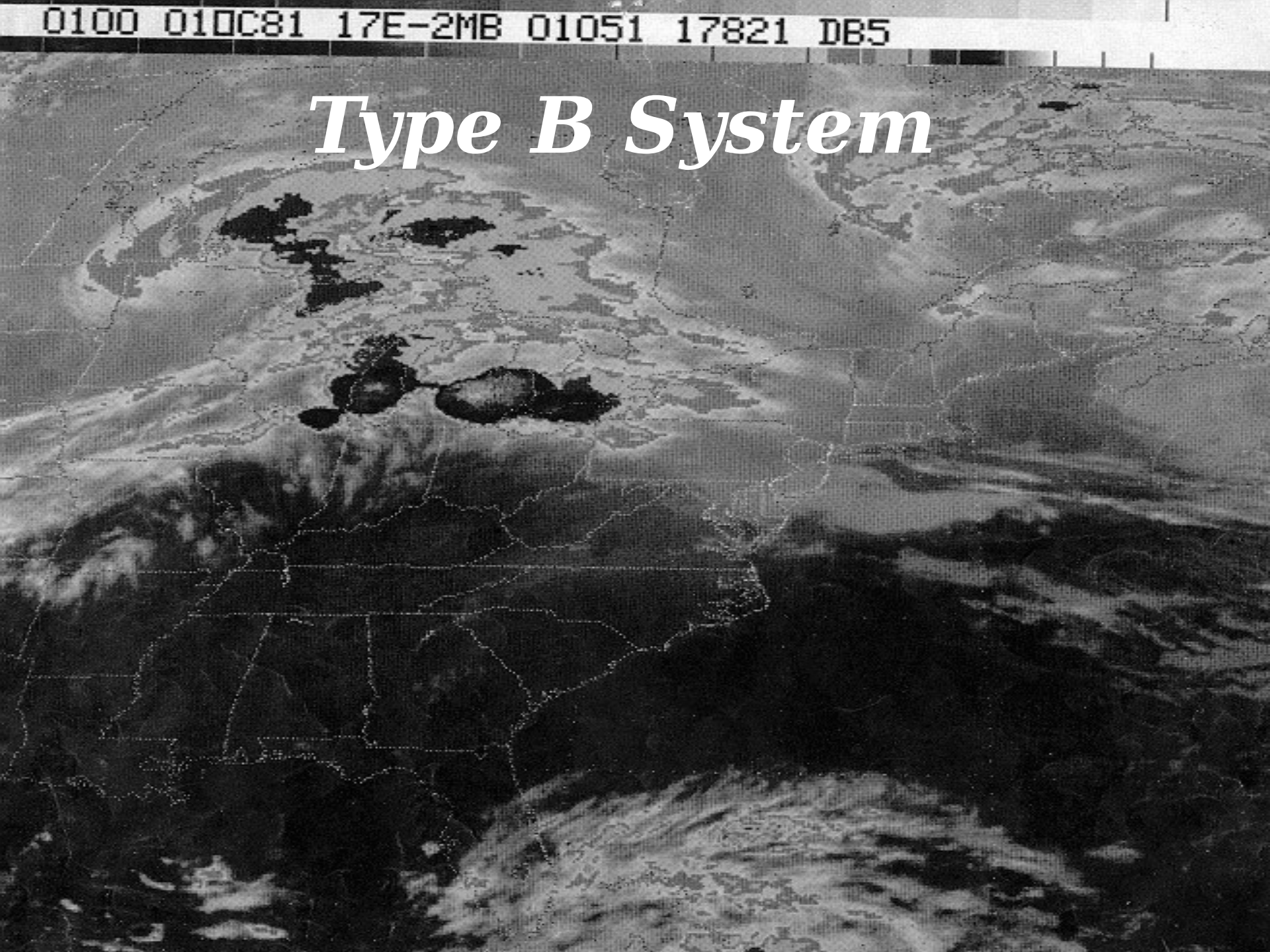
Type B System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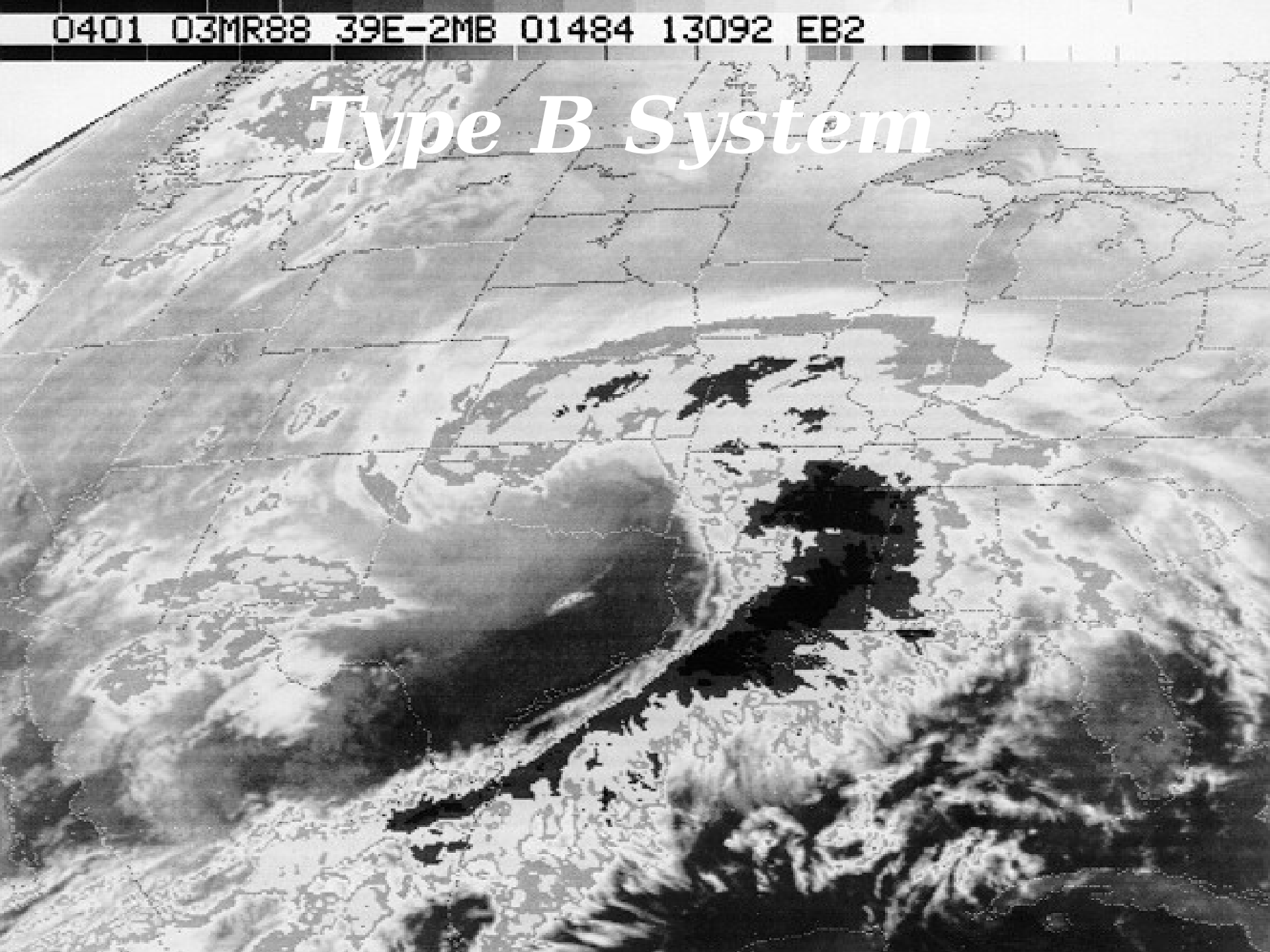
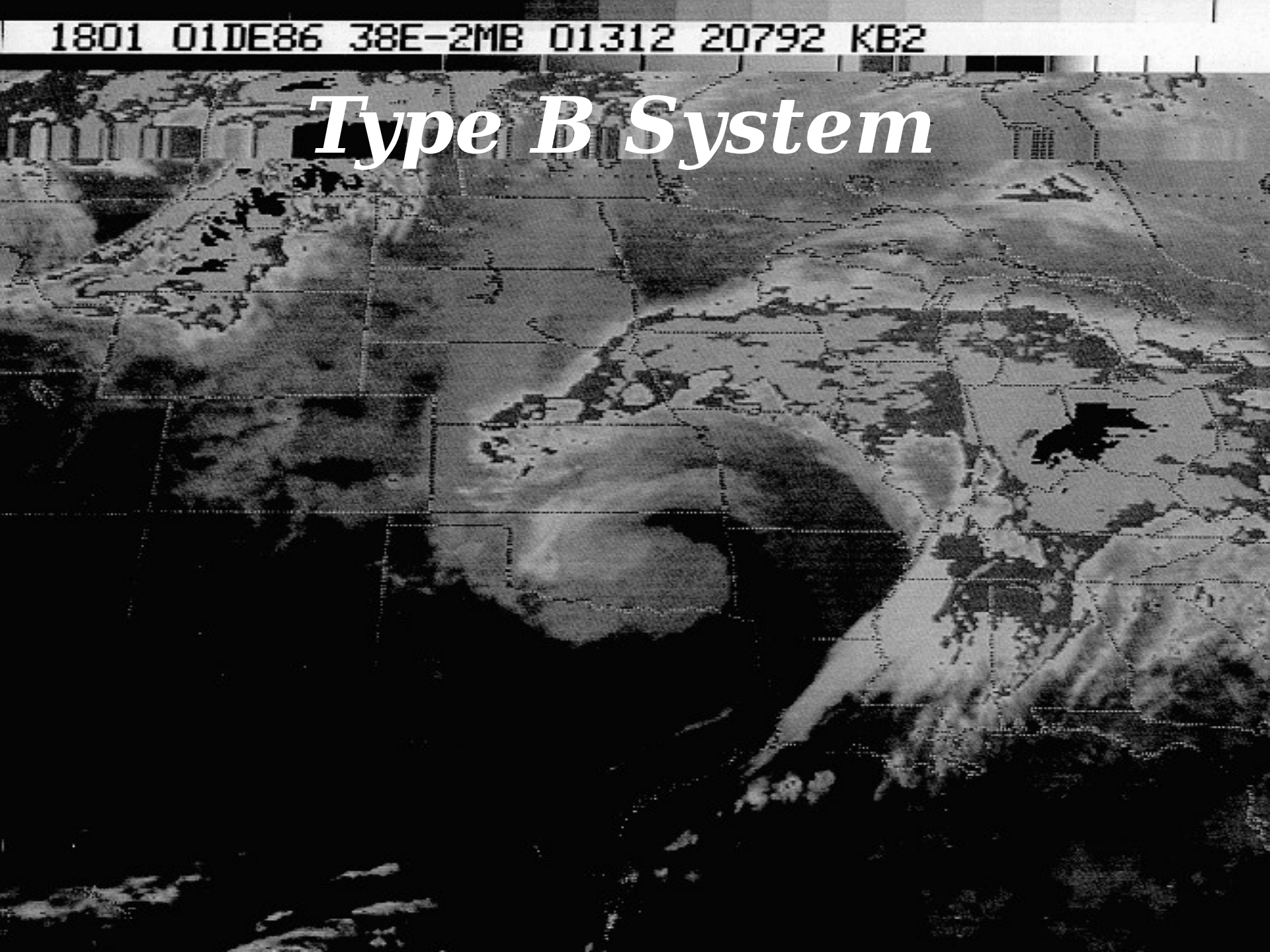
Type B System


0401 03MR88 39E-2MB 01484 13092 EB2
Type B System


1801 01DE86 38E-2MB 01312 20792 KB2
Type B System

- **APPLICATION: Assign Review Exercise 2**

- **EVALUATION: Administer and evaluate Appraisal 302b. Give the written test at the end of the unit**